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ABSTRACT

This document is the second volume of a state curriculum guide on vocational agriculture for use in the 9th and 10th grades in Louisiana. Four instructional areas are profiled in this volume: environmental protection, career information, energy conservation, and agricultural mechanics. The environmental protection unit covers safe use of chemicals, while the two units of the career information area cover introduction to agriculture and occupational training, placement, and advancement. One unit presents information on conserving energy on the farm, while the agricultural mechanics instructional area contains seven units covering orientation to agricultural mechanics, woodworking (basic), tool fitting, electricity, woodworking (sophomore), small engines, and arc welding. Each unit contains one to four individual lessons, with student objectives (terminal and specific), suggested teaching materials, special arrangements for the teacher to make, tips on presenting the lesson, content outlines, and suggested student activities An extensive section of transparency masters and accompanying scripts as well as student materials completes the units. (KC)

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STATE OF LOUISIANA

DEPARTMENT OF EDUCATION

BULLETIN 1690-II

THE BASIC PROGRAM OF VOCATIONAL AGRICULTURE IN LOUISIANA
AG I and AG II
(9th and 10th grades)

VOLUME II

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
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Spring, 1983

Office of Vocational Education

N. J. Stafford, Jr., Ed.D.
Assistant Superintendent

J. KELLY NIX
STATE SUPERINTENDENT

CE 035 993

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FOREWORD

This curriculum guide is a result of extensive work on the part of numerous agricultural educators. The materials included here were developed for the express purpose of aiding secondary vocational agriculture teachers. The hope is that by having practical and usable teaching materials in their hands, teachers will be able to make improvements in their instructional program as well as have increased time available to spend on other phases of the total vocational agriculture program.

I wish to express my personal gratitude and that of the Department of Education to each vocational educator whose efforts and expertise were contributed throughout the development of this curriculum guide. The results of your efforts will significantly benefit vocational agriculture teachers and students in Louisiana.

J. Kelly Nix

J. KELLY NIX
State Superintendent
Department of Education

ACKNOWLEDGEMENTS

This publication represents the cooperative efforts of personnel in the Department of Vocational Agricultural Education, Louisiana State University and the Vocational Agriculture Section in the Office of Vocational Education, Louisiana State Department of Education. Special recognition goes to Dr. Michael F. Burnett who served as project director in the development of the guide. Special commendation goes also to members of the writing team who worked diligently to make this publication a reality.

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A special acknowledgement to the Curriculum Materials centers at AAVIM (American Association of Vocational Instructional Materials), Texas A&M University, and Oklahoma State University. These centers made numerous contributions to this project by allowing relevant materials already in existence to be freely adapted for use in this curriculum guide.

The following Louisiana Vocational Agriculture Teachers gave freely of their valuable time to serve on the curriculum review panel.

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Lionel Wells

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N. J. Stafford, Jr., Ed.D.
Assistant Superintendent
VOCATIONAL EDUCATION

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TEACHING SCHEDULE

UNIT	VOCATIONAL AGRICULTURE I and II
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TOTAL	6 hours

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ENERGY CONSERVATION
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TOTAL	4 hours

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AGRICULTURAL MECHANICS
TEACHING SCHEDULE (CONTINUED)

UNIT		VOCATIONAL AGRICULTURE	
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VII.	Arc Welding Lesson 1: Fundamentals in Arc Welding Lesson 2: Shop Exercises in Arc Welding		12
	TOTAL	29 hours	28 hours

INSTRUCTIONAL AREA: Environmental Protection

INSTRUCTIONAL UNIT: Safe Use of Chemicals

LESSON: Water, Land, Air, and Food Pollution Control

I. Preparation for Instruction

A. Student Objectives

1. Terminal: To use chemicals (Pesticides and Fertilizers) safely with regard to the environment.

2. Specific:

a. Identify reasons for using chemicals safely.
b. List ways chemicals can harm the environment.
c. Purchase the correct chemicals and understand the label.
d. List ways chemicals move through the environment.
e. Explain the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended.
f. Define residues.
g. Define tolerances.
h.

i.

j.

B. Review of Teaching Materials

1. McVickar, M. H. and W. M. Walker. Using Commercial Fertilizers. 4th Edition, Danville, Ill.: Interstate Printers and Publishers, Inc., 1978.

2. Lee, J. S. Commercial Catfish Farming. Danville, Ill.: Interstate Printers and Publishers, Inc., 1973.

3. Apply Pesticides Correctly, A Guide for Private Applicators. Dept. of Agriculture, U.S. Environmental Protection Agency. Washington, D.C.: Government Printing Office, 1980.

4. Apply Pesticides Correctly, A Guide for Commercial Applicators. Dept. of Agriculture, U.S. Environmental Protection Agency. Washington, D.C.: Government Printing Office, 1980.

C. Special Arrangements

1. Materials: EPA Brochures on responsibilities under pesticide laws
Office of Public Affairs
U.S. Environmental Protection Agency
Washington, D.C. 20460

2. Movie on pollution, the environment, etc.

II. Presentation of Lesson and Suggested Student Activities

A. Motivation

1. Short colorful movie depicting our environment and what can be lost by improper use of chemicals.

2. Discuss why we must protect the land, water, air, and food.

B. Content Outline

1. Terms

a. Surface Runoff -- rainfall which does not soak into the earth, which may pick up harmful residues or pests.

b. Effluent -- waste water

c. Contamination -- impure

d. Aquatic -- with water

e. Fertilizers -- nutrients (food) for living organisms

f. Herbicides -- substances used to kill unwanted plants (weeds)

g. Insecticides -- substances used to kill unwanted insects

h. Pesticides -- substances used to kill pests

i. Carcinogenic -- can cause cancer

j. LC50 -- concentration of an active ingredient in air which is expected to cause death in 50 percent of the animals treated

k. LD50 -- dose of an active ingredient taken by mouth or absorbed through the skin which is expected to cause death in 50 percent of the animals treated

l. Leaching -- movement of a substance downward or out of the soil as a result of water movement

m. Pollutant -- an agent or chemical that makes something impure or dirty

n. Tolerance -- 1) the ability to withstand bad conditions
2) amount of pesticide that may safely remain in or on raw farm products at time of sale

o. Residues -- matter remaining after the time of application 4

2. Reasons for using safety precautions with chemicals.

   a. Chemicals in the air can drift which may kill crops, livestock, or man.

   b. Life in water such as fish and plants can be wiped out by careless use of chemicals and disposal of waste.

   c. Pesticides that may cause sickness and production losses can build up in living bodies.

   d. Impure and polluted environments can not be enjoyed by man or animal.

3. Ways in which chemicals and pollutants move through the environment.

   a. Air and gas movement -- heavy gases fall and light gases rise.

   b. Water, rain, rivers, and streams, oceans, and waste systems spread pollutants.

   c. Wind--blows solid and liquid particles.

   d. Solids travel with carriers, such as on animals or agricultural products.

4. Understanding labels (Pesticides and Fertilizers)

   a. Complete fertilizers contain Nitrogen (N), Phosphorous (P), and Potassium (K).

      1) Bag analysis always in the same order N-P-K.

      2) Analysis is given in pounds per 100 lbs. 10-10-10 10#N, 10#P, 10#K 70# of other elements

      3) Labels must list ingredients and the guarantee analysis.

   b. Pesticide labels give much information

1) Brand Name -- name used in advertising
-- most identifiable on label

2) Type of formulation -- liquids, dust, etc.

3) Common Name -- same for all different brands

4) Ingredient statement -- what makes up the pesticide

5) Net contents -- pounds, ounces, grams, liters

6) Name and address of manufacturer

7) Registration and establishment numbers

8) Signal words and symbols
Danger -- highly toxic -- skull and crossbones
Warning -- moderately toxic
Caution -- low toxicity
All labels must read -- Keep Out of Reach of Children

9) Precautionary statement -- tells the ways a product may be harmful and includes precautions to take when using the product

10) Statement of Practical Treatment -- gives first-aid measures

11) Statement of Use Classification
general -- for use by the general public
restricted -- for use only by certified applicators or those under their supervision

12) Directions for Use
Instructions for correct use
Include -- misuse statement
-- reentry statement
-- category of applicator
-- storage and disposal directions

5. Food contamination by pesticides

    a. Follow label directions for the time period between application and harvest (10 days, 2 weeks, 45 days, etc.)

    b. Residues (pesticides that remain on raw farm products) are considered as food additives by the EPA and RDA Food and Drug Administration.

    c. If more residue is found on food than allowed, the food may be seized and condemned.

    d. American consumers rely on the farmer to protect their health by following the label directions when applying pesticides.

6. Federal Insecticide, Fungicide and Rodenticide Act, as Amended (FIFRA) 1972

    a. All pesticide uses classified as either general or restricted.

    b. Persons must be certified as competent to use any of the pesticides classified for restrictive use.

    c. Penalties are provided for those who disobey the law.

    d. All manufacturers must register every pesticide with the EPA (Environmental Protection Agency).

    e. The applicator is responsible for proper pesticide use and must follow federal, state, and local laws.

    f. Penalties can be as much as $25,000 or one year in jail or both.

7. Other Regulations

    a. Department of Transportation (DOT), regulates shipment of dangerous substances.
        Ship pesticides only in the original container.

b. Federal Aviation Administration (FFA) regulates aerial application of pesticides and fertilizers.

c. The Occupational Safety and Health Administration (OSHA) regulates employers with 11 or more workers. They must make reports of work related accidents other than those requiring only first-aid.

d. Residue Tolerances set by EPA (Environmental Protection Agency)

   1) Expressed as parts per million (ppm)

   2) Follow label directions on number of days to apply before harvest

8. Do's and Don'ts in the use of pesticides

   a. Do's

      1) Use only on those pests listed on the label.

      2) Use protective clothing.

      3) Read the label:

         a) Before you buy,
         b) Before you mix, and
         c) Before applying.

      4) Keep out of the reach of children.

      5) Keep under lock and key.

      6) Wash with soap and water after applying.

      7) Keep in original containers.

      8) Avoid drift.

      9) Discard empty containers according to label directions.

   b. Don'ts

      1) Mix pesticides in an enclosed area.

      2) Allow pesticides to splash or spill.

3) Apply on a windy day.

4) Smoke when handling pesticides.

5) Eat or drink until hands are washed.

6) Allow children to play near a treated area.

9. Symptoms of Pesticide Poisoning

a. Headache

b. Giddiness (giggling)

c. Blurred vision

d. Nausea (upset stomach)

e. Confusion

f. Diarrhea

C. Suggested Student Activities

1. Apply for certification.

2. Collect labels and identify parts of the label.

D. Study Questions

1. What is FIFRA?

2. What kinds of information can be obtained from a pesticide label?

3. How do you become certified to apply restricted pesticides?

4. List ways that chemicals move through the environment.

5. Give two words that mean impure.

6. What is the best source of information on the use and misuse of specific substances?

7. List symptoms of pesticide poisoning.

8. How are the words tolerance and residue related?

9. What can happen to farmers who do not obey the FIFRA regulations? 9

10. What is the EPA?

INSTRUCTIONAL AREA: Career Information

INSTRUCTIONAL UNIT I: Introduction to Agriculture

LESSON 1: The Agricultural Industry and You

I. Preparation for Instruction

  A. Objectives

    1. Terminal: Examine the agricultural industry as a possible career.

    2. Specific:

      a. Define terms associated with personal assets.
      b. Discuss the importance of a career choice.
      c. Explore reasons for interest in agriculture.
      d. Identify personal qualifications and assets.
      e. List agricultural qualifications and assets.
      f.

      g.

      h.

  B. Review Teaching Material

    1. Hoover, Norman K. Handbook of Agricultural Occupations. Danville, Illinois: Interstate Printers and Publishers, Inc., 1977.

    2. Stone, Archie A. Careers in Agribusiness and Industry. Danville, Illinois: Interstate Printers and Publishers, Inc., 1970.

C. Special Arrangements

1. Invite a guidance counselor to address students regarding testing procedures available.

2. Provide copies of the Dictionary of Occupational Titles (DOT), the Occupational Outlook Handbook (OOH), and Exploring Careers (Labor Dept.)

3. Arrange field trips in the local community for purpose of identifying different aspects of the agricultural industry.

II. Presentation of Lesson and Suggested Student Activities

A. Motivation

One of the most important decisions an individual will ever make is a choice of a career. The career a person chooses will determine where he will live, the people with whom he will associate, the satisfaction and salary earned from work, and in general, the kind of person an individual becomes. An effort to find out whether an individual is interested in and suited for an occupation in the broad career area of agriculture can be a step toward a successful career. Several ways that an individual's future may be affected by a career choice are as follows:

1. The occupation one chooses may determine the stability of employment.

2. The occupation one chooses may determine the persons with whom one associates.

3. The occupation one chooses may determine his/her degree of success in work.

4. The occupation one chooses may determine whether he/she likes work.

5. The occupation one chooses may determine his/her contribution to society.

B. Content Outline

1. Terms

   a. Ability -- refers to one's capacity to perform.

   b. Talents -- things that one does well.

   c. Physical make-up -- refers to the health, strength, and stamina of individuals.

   d. Interests -- the things people enjoy most and do best.

   e. Values -- those things most important to a person.

   f. Self-concept -- the way that one sees oneself.

   g. Personality -- the traits which a person possesses that separate him/her from other people.

   h. Career -- totality of one's work experiences.

   i. Attitude -- a feeling or mood.

2. What is the agricultural industry?

   This term refers collectively to:

   a. The industries producing agricultural commodities,

   b. The industries and businesses supplying and servicing those engaged in agricultural commodity production, and

   c. The industries and businesses performing all the necessary functions in making agricultural commodities available to the consumer.

   The field of agriculture offers a large number of occupations from which to choose representing production, off-farm occupations, and professional occupations.

4 3. Possible reasons for interest in agriculture.

   a. Needing to decide on an occupation,

   b. Wanting advice on what to do after high school,

   c. Wanting to learn trades,

   d. Trying to choose the best subjects to prepare for jobs,

   e. Needing to know more about occupations, and

   f. Needing to decide whether or not to go to college.

4. Agricultural qualifications and assets

   Knowledge and skills used in performing a certain kind of work are sometimes qualifications for an occupation. A working knowledge of modern farming and agricultural training or experience are required in many off-farm agricultural occupations. Work with plants and animals or experience in an agricultural business provides a background that will serve well in many agricultural occupations.

C. Student Activities

   1. In a written report define what is meant by the agricultural industry.

   2. Prepare a list of work experiences related to agriculture.

   3. Schedule an appointment with the school counselor and review any achievement, interest, or aptitude tests completed.

INSTRUCTIONAL AREA: Career Information

INSTRUCTIONAL UNIT I: Introduction to Agriculture

LESSON 2: Some Career Opportunities in Agriculture

I. Preparation for Instruction

A. Objectives

1. Terminal: Make a study of general information about occupations and relate to suggested career opportunities in agriculture.

2. Specific:

a. State desired characteristics to look for in an occupation.
b. Define terms associated with agricultural occupations.
c. Classify occupations in agriculture.
d. Explore the description and nature of work for selected occupations in agriculture.
e.
f.
g.

B. Review Teaching Material

1. Hoover, Norman K. Handbook of Agricultural Occupations. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1977.

2. Stone, Archie A. Careers in Agribusiness and Industry. Danville, Illinois: The Interstate Printers and Publishers, Inc., 1970.

C. Special Arrangements

Students should have access to the results from any interest or aptitude tests they have taken. Any information other than test scores that might influence their tentative selection of a possible occupational cluster should be available.

II. Presentation of Lesson and Suggested Student Activities

A. Motivation

The agricultural industry is an important part of the world of work. Of the total civilian labor force in the United States, less than five percent is actively engaged in producing food and fiber on farms and ranches, and 15 to 20 percent is engaged in providing supplies and services to farmers and/or processing, transporting, storing, and selling agricultural products. Agriculture in America is continuing to grow and offers many new agricultural occupations.

B. Content Outline

1. Terms

   a. Agribusiness -- refers to the "inputs" of producing food and fiber -- processing and marketing.

   b. Agricultural occupation -- an occupation involving knowledge and skills in agricultural subjects -- farm machinery mechanics, forestry and agricultural supplies salesperson, teacher of agriculture.

   c. Career -- A course of continued progress in the lifework of a person or progress through life in a series of related occupations or activities.

   d. Career pattern -- The sequence of occupations in the life of an individual that makes up a career.

   e. Occupational choice -- The elimination of some occupations and the retention of others, until eventually, an occupational choice is made.

   f. Job -- A job is a piece of work which is rather specific and definite in nature.

   g. Agricultural world of work -- A complex of agricultural occupations that makes up the total field of the agricultural industry.

2. Characteristics to look for in an occupation for job satisfaction.

   a. Creativity -- new and better ideas

   b. Companionship -- talking with others having similar interests

   c. Belonging -- being identified with something larger

   d. Service -- being important to someone

   e. Security -- steady employment

f. Success and advancement -- opportunities to advance to other positions that are higher on the pay scale

g. Working conditions -- an atmosphere that is liked (outdoors, indoors, working alone or with people, manual work)

3. Types of agricultural occupations

a. Occupations in agricultural production. These occupations are related to farming and ranching and include the actual on-farm production of food and fiber (the growing of plants and animals).

b. Occupations in agricultural business, industry, and service. This group includes off-farm agricultural occupations for which some knowledge and skills are needed in one or more of the following areas: plant and soil science, animal science, agricultural mechanics, and agricultural business.

C. Student Activities

1. Each student will prepare a list of his experiences with animals, plants, mechanics, and business and management.

2. Each student will examine the seven broad areas of the agricultural industry and the occupations within each. Compare relationships between experiences and interests listed and the occupational description given.

3. Each student will decide on a general area of interest to further explore by

a. Listing individual observations and experience related.

b. Making a list of businesses that employ persons in the occupational area.

c. Visiting several businesses or farms engaged in the area selected.

d. Making a list of equipment, supplies or other materials produced, handled, or used in the occupational area.

e. Visiting several businesses in the area selected, and diagramming the flow of products or materials.

f. Pretending to be employed in an occupation of the student's choice and answering the following:

   1. Where would one work?

   2. How would one get there?

   3. Who would one see at work?

   4. What personal needs does one feel he/she would be meeting?

   5. How would this employment affect one's social life and leisure time activities?

   6. How would this work affect one's family life and one's financial welfare?

INSTRUCTIONAL AREA: Career Information

INSTRUCTIONAL UNIT II: Occupational Training, Placement, and Advancement

LESSON 1: Preparing for a Career

I. Preparation for Instruction

A. Objectives

1. Terminal: Select career option based on work values and demonstrate knowledge of competencies, education, and training needed for that career.

2. Specific:

a. Identify specific career or occupational cluster that seems most appealing to the student.
b. Identify competencies needed in that career or cluster and possible training or educational opportunities available.
c. Use the Dictionary of Occupational Titles (DOT), the Occupational Outlook Handbook (OOH), or other references to identify careers or occupational clusters.
d.
e.
f.

B. Review Teaching Material

1. Smith, Charles W., J.C. Atherton, and others. Pounding the Pavement: Employment Seeking Skills. School of Vocational Education, Louisiana State University, Baton Rouge, 1979.

11

2. U.S. Department of Labor. Dictionary of Occupational Titles. Washington, D.C.: U.S. Government Printing Office, 1977.

3. U.S. Department of Labor. Occupational Outlook Handbook. Washington, D.C.: U.S. Government Printing Office, 1980-81. (This is updated every two years.)

C. Special Arrangements

1. Materials

a. Several copies of the Dictionary of Occupational Titles (DOT).

b. Several copies of the Occupational Outlook Handbook (OOH).

2. Travel

Student visits to local establishments of career choice(s).

3. Audio-visual equipment

a. Overhead projector/transparencies

b. Slides on job outlook from the Occupational Outlook Handbook.

II. Presentation of Lesson and Suggested Student Activities

A. Motivation

Discuss importance of career planning and consequences of neglect in plans for the future.

B. Content Outline

1. Job values and career satisfaction

Job values are those things that we feel about work. We can understand one's feelings by asking oneself these questions:

a. Why do people work?

b. How do people feel who are satisfied with their work?

c. How important is their job to them?

d. What priority do they give their work in relation to other aspects of their lives, i.e. family, recreation, etc.?

Research tells us that most workers today are, for the most part, satisfied with their work and are motivated by self-fulfillment. In other words, they are concerned with their own futures.

One of the most important reasons why people are dissatisfied with their job is that their choice of a career was not carefully thought through in the first place. They stumbled into their jobs and may be afraid to leave for fear of not finding another job. This should indicate to a person the importance of planning before seeking a job and then not settling for just any job but one that one feels will give job satisfaction.

Everyone has certain basic needs such as food, clothing, and shelter. Other needs may be met through a person's work. These needs include:

a. Money -- earning a living

b. Economic security -- basic necessities plus luxuries

c. Human relations -- working and socializing with others

d. Recognition -- wanting to feel important

e. Helping others -- paid and unpaid employment

f. Independence -- on one's own financially

g. Self-expression -- the expression of one's own personality

h. Achievement -- reaching goals set for self and family

2. Selecting a Career

Making tentative career choices is the first step to choosing an occupation. Each of the following occupational clusters taken from the D.O.T. contains many occupations. A few are listed as examples of the jobs contained in that cluster. The cluster title numbers correspond with the D.O.T. classification numbers for that group. (Transparency II-1-A OCCUPATIONAL CATEGORIES: U.S. DEPARTMENT OF LABOR)

C. Student Activities

1. Have students interview one person whom they feel is satisfied with his occupation and one person who seems to be dissatisfied. Be sure that they include vital information such as age, job title, and reasons for his feelings. Oral reports would be an effective method of conveying information to the class.

2. Have students list those needs that they feel are most important to them concerning their work.

3. Have students choose one occupational cluster from the list presented in which they seem to be most interested. If they are undecided on a particular career, have them choose about three occupations from the D.O.T. listings in the cluster of their choosing. If they already have a vocational preference, have them find the title and description of their career choice.

4. Students should make a report of each occupational choice including pictures of workers on the job, interviews with workers in the field, a description of the job, salaries, and competencies needed for the job. They should also outline the steps that would be necessary to prepare for the job. 14

OCCUPATIONAL CATEGORIES:
U.S. DEPARTMENT OF LABOR

1. PROFESSIONAL, TECHNICAL, AND MANAGERIAL:

   architect, lawyer, artist, drafter, electrician, engineer, land surveyor, geologist, soil scientist, forester, horticulturist, veterinarian

2. CLERICAL AND SALES:

   secretary, clerk-typist, keypunch operator, personnel clerk, mail clerk, cashier, real-estate clerk, telephone operator, tourist information assistant

3. SERVICE:

   home housekeeper, waiter/waitress, chef, meat cutter, barber, hairdresser, make-up artist, flight attendent (airline), fish and game warden

4. AGRICULTURAL, FISHERY, FORESTRY, AND RELATED:

   farm worker, park worker, greenskeeper, tree trimmer, forest-fire fighter, general farmer, fish farmer, animal trapper

5. PROCESSING:

   caster, steel pourer, sandblaster, die-casting machine operator, pickler, nut chopper, wine fermenter, pasteurizer, cake decorator

6. MACHINE TRADES:

   tool-grinder operator, wheel cutter, barrel rifler, needlemaker, inspector, brake adjuster, motorcycle repairer, tractor mechanic

7. BENCHWORK:

   jeweler, silversmith, solderer, engraver, lensmounter (eyeglasses), pipe organ builder, toy assembler, custom ski maker, framer

8. STRUCTURAL WORK:

   riveter, test driver, auto assembler, welding machine operator, line repairer (light, heat, and power)

TRANSPARENCY II-1-A

9. MISCELLANEOUS:

dump truck driver, ferryboat operator, film developer, book binder, legend maker, screen printer

TRANSPARENCY II-1-A (cont'd)

INSTRUCTIONAL AREA: Career Information

INSTRUCTIONAL UNIT II: Occupational Training, Placement, and Advancement

LESSON 2: Personal and Social Competencies Needed for Employment

I. Preparation for Instruction

A. Objectives

1. Terminal: Develop and organize information needed to complete a resume and use composition skills to compose an application letter, in addition to completing job application forms.

2. Specific:

a. Identify types of information to be included in a resume and place information in proper order.
b. Develop and type a resume.
c. Compose and type an acceptable application letter.
d. Complete a standard job application form accurately, neatly, and completely.
e.

f.

g.

B. Review Teaching Material

Smith, Charles W., J.C. Atherton, and others. Pounding the Pavement: Employment Seeking Skills. School of Vocational Education, Louisiana State University, Baton Rouge, 1979.

C. Special Arrangements

1. Materials

a. Standard application forms

b. Example of poorly completed resume

c. Example of neat, well-composed resume

2. Travel

Student visits or contacts former employers and persons used as references.

3. Audio-visual equipment

Overhead projector/transparencies (optional)

II. Presentation of Lesson and Suggested Student Activities

A. Motivation

1. Display examples of a poorly prepared resume and others that are neat and well-prepared. Discuss students' reactions to each. Ask students which person they would hire based on his resume. Why?

2. Discuss students' experiences in filling out application forms. What would have made it easier to fill one out? Were they prepared with the correct information?

B. Content Outline

1. Completing a Resume

A resume could be considered an advertisement for oneself. In a sense, a person is selling his skills, knowledge, experience, and attitude to prospective employers through resumes and interviews. A resume can "fill in the gaps" of information that one wants to make available to the employer in addition to the interview. It is used primarily to help a person get an oral interview.

There are three main parts to a resume.

a. Introduction

The introductory part of a resume should include:

1) Full name -- no nicknames,
2) Address,
3) Home telephone number,
4) Business telephone number (only if one wishes to be contacted there), and
5) Job objective -- may include short-term goal or immediate jobs or long-term goal or the job that a person wants five to ten years from now.

b. Main Body

The main body of the resume should include:

1) Educational background -- should indicate highest level achieved.
2) Work experience -- may be placed before education if this is the stronger point.

3) Related skills and activities -- membership in school and community organizations, community service and leadership activities, plus related skills such as typing, art, etc.

4) Personal data -- optional information such as age, race, health, marital status, travel experience, hobbies, etc.

c. Conclusion

The conclusion of one's resume should include:

References -- should be persons who are not relatives and can vouch for the personal character and/or working ability. One should always ask his permission before listing someone as a reference. Always include the reference's full name, home address, telephone number, and relationship of the reference (clergy, principal, employer, etc.)

2. Writing a Letter of Application

A letter of application or cover letter usually accompanies the resume. The letter emphasizes those points in one's resume that are directly related to the job that one is seeking. For each job that a person applys for, an application letter with special references to the employer and the job is necessary.

The application letter has three main purposes.

a. It should increase the employer's interest in the applicant.

b. It should encourage the employer to read the applicant's resume.

c. It should encourage the prospective employer to arrange an interview if the information was mailed to th employer.

The application letter has three parts.

a. Introduction

It should attract the employer's interest and develop a feeling of rapport between the employer and applicant. Always be sincere and honest, use plain English, and be respectful in your opening lines. Don't turn the reader off before he gets started.

b. Main Body

The main body should be used to tell the prospective employer why the applicant should get the job. This is the place for emphasizing either work experience or educational experience, personal background, and personality.

c. Conclusion

The conclusion is the final impression that one leaves with the prospective employer. In the conclusion one should include the desire to provide additional information and give the employer a chance to make an appointment by providing information as to when one will be available for work.

Other necessary items that should be included in the letter are:

1) Return address,

2) Inside address,

3) The salutation,

4) The signature -- written and typed, and

5) Notice of enclosure (resume).

3. Completing Application Forms

A major complaint of business people today is that students and graduates do not know how to fill out application forms. The main reason for incomplete and sloppy forms is that people have not taken the time to organize the information needed into a usable form but rather have had to trust their memory and consequently have left blanks and corrections marring the application form as well as their chances for employment. The application form indicates to the employer the type of employee the person would be neat or careless, haphazard, or thorough.

After completing a resume, one should have available much of the information needed to complete an application form. All that is needed is to follow directions and take the time to complete the form accurately and neatly.

There are three sections on an average application form.

a. Personal information

Information is needed that identifies a person such as his name, address, telephone number, and social security number. Age, race, sex, religion, etc. are optional. If it is to one's advantage to include them, do so. If it is not wise to include such information, exclude it.

b. Employment desired

Be specific about job titles or use general descriptions such as general office work or general construction work. This shows that a person has more direction than someone who answers that he will take anything.

Be specific about the available starting dates. Don't forget that it is customary to give two weeks notice to the present employers if one plans to quit your present job.

Salary requirements are a touchy subject. A person may price oneself out of a job or give an employer the opportunity to offer less than usual if one states an exact figure. One should do his/her homework. Know the average salary range for the job that one is applying for or answer "open" which means that he/she will negotiate salary.

c. Education and work experience

Information concerning years and places of school attendance and work experience should be transferred from the resume. Observe the number of blanks provided to determine if only grammar and high school will be provided or if junior high will be included also. It is best to put the last school attended first, and always include any post high school training.

Work experience is easier to record if one places it in chronological order. Put the last place worked first and be sure to include names and addresses and job titles.

If there are any blanks that do not apply, show that the person has read the instructions by placing a "does not apply" or N/A in the blank.

References are an important part of the application form. Use both character and work experience references from the list of one's resumes.

C. Student Activities

1. Have students complete a personal resume. Students should evaluate their resume for any errors or imcomplete sections. Each student should have a complete, typed resume suitable for use in job applications.

2. Have students compose, type, and attach to the resume an application letter to each prospective employer in the career option(s) that they have chosen.

3. Have students complete an application form neatly and accurately using the previously completed resume to organize the information needed.

Personal Data Sheet

Name:

Address:

Home telephone number: (   )

Business telephone number: (   )

Job objective:

Education:

Work experience:

Activities, honors and skills:

College:

High school:

Church and community:

Skills:

Personal data:

Age: Birthdate:

Race: Health:

Marital status: Travel:

Hobbies:

References:

INSTRUCTIONAL AREA: Career Information

INSTRUCTIONAL UNIT II: Occupational Training, Placement, and Advancement

LESSON 3: Getting a Job

I. Preparation for Instruction

A. Objectives

1. Terminal: Locate job opportunities using several different sources in selected career option(s).

2. Specific:

   a. Name 10 sources in which to locate job opportunities.
   b. Organize a job search using at least five different sources of job openings.
   c. List factors that influence an employer's choice of employees.
   d.
   e.
   f.

B. Review Teaching Material

Smith, Charles W., J.C. Atherton, and others. Pounding the Pavement: Employment Seeking Skills. School of Vocational Education, Louisiana State University, Baton Rouge, 1979.

C. Special Arrangements

1. Materials

   a. Several copies of telephone "Yellow Pages" of closest municipality.

b. Several copies of the classified ads section of the local newspaper.

2. Travel

Student interviews with prospective employers as a result of their organized job search.

3. Audio-visual equipment

Overhead projector/transparencies (optional)

II. Presentation of Lesson and Suggested Student Activities

A. Motivation

Hold discussion with students about their experiences in job hunting. Encourage them to discuss failures as well as successful searches.

B. Content Outline

1. Identifying Job Openings (Student Response Sheet II-3-A)

Looking for a job is a full-time job in itself. There are many different sources for finding jobs, but you must know what they are as well as how to use them. The sources for finding jobs include:

a. Neighborhood advertisements
"Help Wanted" signs can be beneficial to those looking for immediate employment in a certain location. Usually these types of jobs require relatively little training or education so they may be available to most people immediately. They are a good source of jobs for high school students who must live at home but wish to work part time.

b. Relatives and friends
The most effective way of getting a job for many people is to ask friends and relatives if they know of any openings in their companies for which the inquirer may quality.

c. School placement services
Part-time jobs while still in school which may lead to employment after graduation would be an excellent way to gain work experience. Your school guidance counselor and school administrators may be helpful to you in suggesting opportunities or helping in placement.

d. Newspaper "want-ads" (Student Response Sheet II-3-B)
Many people wrongfully consider "want-ads" the only source of available jobs but actually the "want-ads" represent only a small portion of the jobs available. They do offer a good starting point for a job search, though, and may give you an idea of areas in which many people are employed and the salary ranges of these jobs.

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e. Private employment agencies
Most private agencies charge a fee for their services that is usually a small percentage of the starting salary. The fee may be worth it to some considering the agencies usually deal with the better companies and may be able to find a job faster than if you were searching on your own.

f. Apprenticeship programs
Many people train for skilled jobs as an apprentice. These programs are usually sponsored by unions or by large companies. Night classes at a Vo-Tech school are usually required also.

g. Applying to employers directly or "walk-in" applications
Applying directly to a reputable company requires that a person research positions and policies of that company plus have a good knowledge of what the company does.

h. The "Yellow Pages" (Student Response Sheet II-3-C)
Telephone "Yellow Pages" are a good listing of businesses and services in specific areas. They are also a good starting point for a job search but again require more research since one will be applying directly to an employer.

i. Civil Service
Government jobs, whether on the local, state, or Federal level are competitive and require testing, evaluation and referral before hiring. Applying for a Civil Service job is a special process and one that an applicant may need help in completing.

The first step in applying is to contact the U.S. Civil Service Commission, which maintains information about local jobs in the U.S. government, and fill out a Job Interest Card so that the Commission can notify you if there are any openings. You then complete an application and take tests if required. The application and

tests are reviewed and you are 30
ranked along with other applicants for the job. The top three applicants are considered for the job.

j. Louisiana Office of Employment Security
The Louisiana Office of Employment Security, also referred to as the Unemployment Office, attempts to provide young people with two kinds of services.

1) Help in choosing a field of work.

2) Help in securing jobs in keeping with a young person's interests, abilities, and ambitions.

This service offers free vocational counseling, testing, and placement services. Employment Security operates a job bank that is a computerized system through which employers in search of qualified workers list job orders with local employment offices. The job orders usually include such information as job title, pay, industry, geographic location, duration of job, fringe benefits, and experience required; which gives the employment service information to better match people with jobs.

2. The Job Interview (Student Response Sheet II-3-D)

At this point the students should be very familiar with the career options that interest them the most. They have explored characteristics that are most important to them about work and what they expect to gain and to contribute. They have also identified job openings in their career choice and prepared resumes to be used when applying for a job. The next step in securing a job is to schedule a job interview.

Before going for an interview, there is some homework that should be done. The steps include:

a. Schedule an interview the the personnel manager or supervisor.

b. Prepare a folder that includes a resume, a social security card, copies of work if applicable, and a list of questions to ask.

c. Become familiar with the company; what it sells, produces, or services, its size, reputation, etc.

d. Be aware of the specific job for which application is being made.

e. Determine what is a realistic salary range for the job.

f. Make arrangements for transportation and know the exact location of the interview.

g. Be especially particular about personal appearance for the interview.

h. Be on time or a few minutes early.

There are factors that employers use to critique their interviewees. One should be aware of them.

a. Appearance
First impressions are made by one's appearance. Neat, clean, and appropriately dressed applicants have a definite advantage.

b. Education
Most employers prefer high school graduates because the diploma is proof that the person who acquired it stuck with a task until it was finished.

c. Training and experience
Employers usually prefer to hire persons with experience because they already have some work skills. Inexperienced and untrained workers must be willing to start at the bottom and work hard to acquire marketable skills.

d. Attitude
Employers would rather hire a worker with no skills and a good attitude

than one with good skills and work experience but a poor attitude. It is important to be responsible for showing up and caring about the job and the reputation of the company for which one works.

e. Willingness to accept pay scale
Most companies have a pay scale that is based on training, education, experience, and the job itself. A person should be familiar with the salary range for the job for which he/she is applying.

f. Job desired
Know the exact job for which application is being made. If a person seems undecided about the position desired, employers may think that he/she will be aimless and indecisive about work.

g. Work record
A person's former work record should reflect that the person was a good employee. Former employers can be an asset or a liability; it's up to the worker.

h. References
Prospective employers are looking for persons who will say that the interviewee will be an asset to his/her company. If references may be noncommital, don't list them. Also, relatives are not a good choice.

C. Student Activities

1. Have students organize a job search for opportunities available in their chosen career option or options. Have them use at least five sources to find available opportunities. (Student Response Sheet II-3-E)

2. Have those students who are seeking immediate employment schedule and conduct several interviews from their list of available job openings.

3. Conduct mock interviews between students with one playing the role of employer and one the role of employee.

STUDENT RESPONSE SHEET II-3-A

IDENTIFYING JOB OPENINGS THROUGH THE CLASSIFIED ADS

Part 1. Scan the classified ads of your local newspaper and find appropriate jobs for the following job seekers. Record the particulars about the job openings on the survey sheet.

a. A Viet Nam veteran, lost right arm, has high school education. Was previously a truck driver.

b. Female high school graduate. Recently divorced and has two small children. Took typing in high school, but has never worked.

c. Middle aged man with a family. He was employed at a chemical plant as an operator and would like to continue using the skills he learned at that job.

d. Male high school drop-out. He has no employment skills or previous work experience.

Part 2. Scan the classified ads of your local newspaper and find appropriate jobs for the following job seekers. Record the particulars about the job openings on the survey sheet.

a. Welder
b. Florist
c. Butcher
d. Legal secretary
e. Sheet Metal lay-out man
f. Painter
g. Laborer
h. Truck driver

Part 3. Scan the classified ads of your local newspaper and find an opening that you would use as an entry-level job in a career field in which you are interested. Record the particulars about the job on the survey sheet.

Part 4. Scan the classified ads of the local newspaper and find an opening that you would consider if you had to change your occupation after becoming established in a job. Record the particulars about the job on the survey sheet.

STUDENT RESPONSE SHEET II-3-B IDENTIFYING JOB OPENINGS

DIRECTIONS. Scan the classified ads of your local paper and record the particulars about jobs requested in Student Activity 2-2-3.

JOB TITLE	ENTRY-LEVEL EXPERIENCE						ENTRY-LEVEL EDUCATION AND/OR TRAINING						RATE OF PAY				SPECIAL CONDITIONS OR REQUIREMENTS FOR THE JOB (Special physical or attitudinal requirements; aptitudes; tools or driver's license, etc.)	INFORMATION ABOUT PROSPECTIVE EMPLOYER AND DIRECTIONS FOR APPLYING FOR JOB (Name of company, location, telephone no., contact person, etc.)
	None	1 year	2 years	3 years	4 years or more	Unknown	Less H.S.	H.S.	H.S. +1	H.S. +2	H.S. +3	H.S. +4 or more	Hour	Week	Month	Year		
1a.																		
1b.																		
1c.																		
1d.																		
2a.																		
2b.																		
2c.																		
2d.																		
2e.																		
2f.																		
2g.																		
2h.																		
3.																		
4.																		

STUDENT RESPONSE SHEET II-3-C

USING THE YELLOW PAGES

1. You are looking for work as a stock clerk or a delivery person. Go through the Yellow Pages and examine each heading. Ask yourself, "Who are the kinds of people who hire stock clerks or delivery people?" Begin first with companies or businesses that hire a great many people. Companies that do a large volume of business will hire more people than those whose businesses are limited. List three contacts you want to make as you begin your job search. Give names, addresses, telephone numbers, and headings under which you located contacts. (Do not use more than one contact under each heading.)

   a. NAME ______________________________

   ADDRESS ______________________________

   TEL. NO. ______________ HEADING ______________

   b. NAME ______________________________

   ADDRESS ______________________________

   TEL. NO. ______________ HEADING ______________

   c. NAME ______________________________

   ADDRESS ______________________________

   TEL. NO. ______________ HEADING ______________

2. You have heard that there is a great need for plumbers in your community and that they are paid exceptionally well. You are interested in learning the plumbing trade, but this course is not taught in your school. There are several places you can call to get information about learning this trade on the job as an apprentice. Look up these places in the Yellow Pages of your telephone book and list the names, addresses, and telephone numbers.

   a. La. Office of Employment Security: NAME ______________________________

   ADDRESS ______________________________

   ______________ TEL. NO. ______________________________

   b. Employer in this field who would hire apprentices: NAME ______________________________

   ADDRESS ______________________________

   ______________ TEL. NO. ______________________________

c. Joint Apprenticeship Committee for this trade
NAME______________________________
ADDRESS______________________________
TEL. NO.______________________________

d. Union office for this trade
NAME______________________________
ADDRESS______________________________
TEL. NO.______________________________

e. U. S. Bureau of Apprenticeship & Training (Dept. of Labor)
NAME______________________________
ADDRESS______________________________
TEL. NO.______________________________

3. You are interested in finding a clerical job with the nearest local, state, or Federal law enforcement office. To do so, you would have to apply at the City, State, or U. S. Civil Service office. List the addresses and telephone numbers of these offices as you find them in the Yellow Pages.

a. City Civil Service______________________________

b. State Civil Service______________________________

c. Federal Civil Service______________________________

4. You want to find a job doing volunteer work for one of the medical groups, such as Muscular Dystrophy. Locate a list of such organizations in the Yellow Pages. List the names, addresses, and telephone numbers of two such agencies to whom you wish to apply.

a. ______________________________

b. ______________________________

5. Under "Organizations" in the Yellow Pages, you are referred to various kinds of business and civic organizations that may be of help to you in locating a job. Find the following organizations in the Yellow Pages and list their addresses and telephone numbers.

a. Chamber of Commerce______________________________

b. Rotary Club______________________________

STUDENT RESPONSE SHEET II-3-D

MOST FREQUENTLY ASKED JOB INTERVIEW QUESTIONS: HOW WOULD YOU ANSWER THEM?

DIRECTIONS. Below are the ten most frequently asked job interview questions for people of all ages, education, and experience. They are as applicable to the teenager as they are to individuals who are changing full-time jobs for the third and fourth times. Study each question and then decide how you would answer the questions in the most positive and acceptable manner.

Write your answers on a separate piece of paper and be prepared to discuss your answers with your classmates.

---

1. What are your major strengths?
2. What are your major weaknesses?
3. How is your previous experience applicable to this job?
4. Why did you leave your former job?
5. Is there someone we can contact who is familiar with your activities?
6. Where do you see yourself in this company five years from now?
7. What are your interests outside of work?
8. What do you want to be remembered for?
9. Are you applying to other companies?
10. What kind of compensation are you looking for?

SRS II-3-E

RESEARCHING A PROSPECTIVE EMPLOYER

NAME OF COMPANY ____________________

ADDRESS ____________________ TEL. NO. ____________

CLASSIFICATION (Retail Sales, Real Estate, etc.) ____________

NATURE OF BUSINESS: _____ People _____ Data _____ Things

NAME OF LEADING PRODUCT, IF ANY ____________________

HOME OFFICE ____________________

SCOPE OF OPERATIONS (Local, Nat'l, Intern'l; No. of Locations)

____

TYPES OF JOBS ____________________

____

EDUCATIONAL LEVEL OF EMPLOYEES ____________________

NO. OF EMPLOYEES ________ DATE OF FIRM'S ESTABLISHMENT ____________

FOUNDER OF COMPANY ____________________

SHORT HISTORY OF COMPANY (Continue on back) ____________

____

NAME OF TOP OFFICER ____________________

TITLE ____________________

ESTIMATE OF EMPLOYEE MORALE ____________________

FRINGE BENEFITS ____________________

FINANCIAL RATING ____________________

TYPES OF COMMUNITY ACTIVITIES SPONSORED BY COMPANY ____________

____

____

REPUTATION IN COMMUNITY ____________________

____

BASED ON RESEARCH, IS THIS A GOOD COMPANY FOR ME? ____________

INSTRUCTIONAL AREA: Career Information

INSTRUCTIONAL UNIT II: Occupational Training, Placement, and Advancement

LESSON 4: Holding a Job

I. Preparation for Instruction

A. Objectives

1. Terminal: Assesses attitude toward work and list possible attitudes and personality problems that may occur and the solutions to the problems.

2. Specific:

a. List 10 suggestions thay may help an employee have a good relationship with co-workers and employers.
b. Recognize importance of high school grades to prospective employers.
c. List six reasons why most people lose their jobs.
d. Identify a positive type of behavior and a negative type of behavior as related to work.
e.

f.

g.

B. Review Teaching Material

Smith, Charles W., J.C. Atherton, and others. Pounding the Pavement: Employment Seeking Skills. School of Vocational Education, Louisiana State University, Baton Rouge, 1979.

C. Special Arrangements

1. Materials

   Costumes of workers for skits, e. g. supervisor, laborer, office worker, waitress/waiter, etc.

2. Audio-visual equipment

   a. Overhead projector/transparencies (optional)

   b. Tape recorder and/or videotape equipment

II. Presentation of Lesson and Suggested Student Activities

A. Motivation

Discuss how a person's attitude may affect work on the job as well as personal life.

B. Content Outline

1. Success on the Job

Why are some people more successful in life than others? Some like to blame another's success and their own failures on conditions beyond their control, such as family, education, sex, or race. But, in today's world, success is governed by internal factors, such as work habits and attitudes developed early in life.

Business people say today that the best prediction of a worker's performance on the job is his high school report card. College admission officers say the same about a student's success in college. If a student is serious, they say, about his/her school work in high school, that seriousness and sense of purpose usually continue through college and on the job. Only a few who fail at high school suddenly "bloom" in college or on the job.

Very seldom does a miraculous turn-about happen. The work habits and attitudes that one has now will not change that drastically as one gets older, unless one consciously works at changing them. How a person handles himself on the job -- whether or not he possesses those work habits and attitudes that are needed to be successful on the job -- can be predicted by the work habits and attitudes that he exhibits in school and at home right now.

Getting along with others on the job depends, to a large extent, on one's behavior. A person's behavior will reflect his attitude toward his job and coworkers. A positive attitude will improve his relationship with his co-workers; a negative attitude will decrease his chances for success on the job. If one has a good relationship with his co-workers, they will cooperate with him to help him over the rough spots during the adjustment period.

A person's or supervisor is a key person during the first days on the job. Much of the new employee's success will depend on the boss' expectations of him. If the boss expects more than one can give, because of limited education, work experience, and maturity, those first few days on the job will be rocky ones. But, if he accepts the new worker as a beginner, makes allowances for mistakes, and encourages co-workers to help in the learning process, one's first job will become a memorable experience.

There are several suggestions that may help one to be a success on the job.

To please employers, one must:

a. Be honest,

b. Be loyal,

c. Be enthusiastic,

d. Be personable, and

e. Give a full day's work for a full day's pay.

To please co-workers, one must:

a. Proceed with caution about forming association with co-workers,

b. Follow the general company policy about using first or last names in addressing co-workers,

c. Be dependable,

d. Be cooperative,

e. Mind his own business,

f. Work as a member of the team,

g. Graciously take help when needed,

h. Do not join cliques,

i. Develop a sense of humor, and

j. See each co-worker as a worthy person able to make a contribution to the group.

If one loses his job, it will probably be because of one of the following reasons.

a. Excessive absenteeism or tardiness,

b. Inability to take constructive criticism,

c. Unwillingness to learn,

d. Failure to show interest in the job,

e. Inability to follow instructions, and

f. Inability to get along with people on the job.

The secret to getting along on the job is to develop a positive attitude toward:

a. The company,

b. The boss or supervisor,

c. Co-workers,

d. The job, and

e. Oneself.

2. People on the Job

Being able to maintain a successful working relationship with both one's supervisor and co-workers is an important factor in determining success on the job. This is probably just as important as ability to perform the job tasks. In fact, surveys have indicated that more people lose their jobs because of their inability to get along with co-workers and supervisors than because of their inability to do the job.

An important fact to remember is not to take a job for granted. When one first gets a job, there isn't anything that he wouldn't do in order to make a good impression -- to prove that the company did not make a mistake in hiring him. However, as time progresses, one will be inclined, as others are, to find fault with the job and especially with the people.

One must try to guard against this, because job performance will suffer.

How well one gets along with others depends a great deal on one's own behavior. Behavior reflects attitudes -- attitude toward oneself, toward people, and toward work. If a person has a positive attitude, it will improve relationships on the job. He/she will be willing to change, to see other points of view, to accept job tasks and criticism without complaining, and to accept responsbility for his/her work. A negative attitude will lessen chances for job success making one unwilling to change, blaming others for mistakes, wearing unpleasant facial expressions, and frequently criticizing others.

Getting along with people on the job is a difficult task because people have different temperaments, strengths, and weaknesses. People are also not the same every day. Personal problems should be left at home but sometimes one's emotions may affect his work and attitude toward his co-workers.

The new employee can help this situation, by knowing what to expect from co-workers. Then one will not be hurt or disappointed if co-workers act in a way that one does not expect. Some new workers go on the job with chips on their shoulders, just waiting to be offended, insulted, discriminated against, or ignored. Consequently, they bring out negative behavior in their co-workers. If a person goes on the job expecting to be liked and accepted and acting in a way that makes it possible for other people to like, respect, and accept him, co-workers should react in a positive manner.

Good advice to follow:

a. Don't expect the VIP treatment,

b. Expect some teasing,

c. Expect some negative feelings,

d. Don't act as if you know everything,

e. Be friendly,

f. Don't be too critical,

g. Don't go off in a lot of different directions, and

h. Read the employee handbook carefully.

Getting along with people on the job will be the most challenging task as one begins employment. Success in this area will depend upon positive attitudes in dealing with others. A positive attitude includes:

a. A willingness to change,

b. The ability to see other points of view,

c. No complaining,

d. Always having a pleasant manner, smiling, and wearing pleasant facial expressions,

e. Accepting responsibility for one's work,

f. Respecting the opinions of others,

g. Having varied interests,

h. Being considerate of others,

i. Not losing one's temper regularly, and

j. Not being critical of others.

No matter how hard a person tries to get along with his supervisor and co-workers, situations will arise when a conflict will take place. This is only natural when people of differing backgrounds, temperaments, and abilities are working together. The way one handles these situations, however, will indicate how mature he is, how sensitive to other people, and how successful one will be in the future.

When conflicts occur, there is a step-by-step method to follow in resolving the conflict.

a. Define the problem. In defining the problem, one very often solves it.

b. Decide what the outcome of the conflict ought to be.

c. List the varied things (alternatives, options, choices) that one could do to resolve the conflict.

d. Choose the best alternative -- the one that will most quickly and most effectively resolve the problem and produce the desired outcome.

e. Put this alternative into action.

f. After a reasonable period of time, decide if this alternative has produced the desired outcome. If it has not, choose the next best alternative and proceed through Steps "e" and "f" again, until the problem is resolved.

These steps can be used in work as well as personal and family situations.

C. Student Activities

1. Have students make a list of their positive feelings and a list of their negative feelings about working.

2. Have students role play positive and negative attitudes as employees and employers. Have them present a short dialog that shows the problem with the solution.

3. Invite a personnel manager to speak to the class concerning attitudes of workers.

INSTRUCTIONAL AREA: Energy Conservation

INSTRUCTIONAL UNIT I: Conserving Energy on the Farm

LESSON 1: Farm and Homestead Energy Conservation

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Establish energy conservation measures at the farm and homestead.

2. Specific:

    a. Define energy and list uses on the farm.
    b. List types of fuel and energy sources.
    c. Identify insulation types.
    d. Diagram landscape methods that can conserve energy.
    e. Discuss reasons for conserving energy.
    f. Define R-value.
    g. Identify uses for solar energy on the farm.
    h. Identify areas where energy can be saved on the farm.
    i.
    j.
    k.

B. Review Teaching Materials

1. Providing for Energy Efficiency in Homes and Small Buildings. Oakridge, Tenn.: U.S. Department of Energy, 1980.

    1 copy free from:
    U.S. Dept. of Energy
    Technical Information Center
    P. O. Box 62
    Oakridge, Tennessee 37830

2. Pope, Thomas E. *Landscaping for Energy Conservation*. Baton Rouge: Louisiana Cooperative Extension Service, 1980.
3. Baker, F. E. and M. M. Baker. *Home Insulation*. Baton Rouge: Louisiana Cooperative Extension Service, 1980.
4. *Electric Energy*. Athens, Georgia: American Association for Vocational Instructional Materials, 1976.

C. Special Arrangements

1. Field trip to energy efficient farm.
2. Overhead projector
3. 16 mm projector -- movie on energy and its conservation, or The President's FFA Energy Challenge
4. Handout -- Insulating Values of Several Insulating and Building Materials

II. Presentation of the Lesson

A. Motivation

1. List all the appliances that require energy to operate on the farm and in the home. Also, discuss the results if we did not have this energy available.
2. Present the FFA Energy Challenge to the class (Use the 16 mm movie if possible.)

B. Content Outline

1. Terms:

   a. Conservation -- to protect from waste, loss or harm

   b. Radiation -- giving off of waves of light, heat, sound, etc.

   c. Insulate -- to prevent heat, light, or sound from passing through

   d. R-value -- indicator of resistance to heat flow

   e. Energy -- capacity for work

   f. Energy consumption -- energy use

2. Why conserve energy?

   a. The U.S. faces serious energy problems (shortages).

   b. Farms are highly mechanized -- problems associated with this are:

      1) machines use fossil fuels that are in short supply;

      2) fossil fuels cannot be recycled; and

      3) machines are difficult to change over to other energy sources (i.e. solar power).

   c. Increased fuel cost has lowered profits to management and wages to labor.

   d. Technology is not keeping up with the change in energy needs.

3. Types of fuel and other sources of energy

   a. Diesel fuel -- used in practically all machinery over 100 hp.

   b. Gasoline fuel -- main farm transportation fuel

c. Liquid petroleum gas -- mainly for heating buildings and drying crops

d. Natural gas -- primary source for hydrogen in producing ammonia for fertilizers, also used for irrigation, heating buildings, and drying crops.

e. Electricity -- mainly generated from fossil fuels, which are used for lighting, ventilation, pumping water, irrigation, and heating.

f. Lubricants -- not used as fuel, but contain usable energy.

g. Aviation fuel -- for planting, spraying, and fertilizing

h. Solar energy -- used primarily for heating buildings and water.

4. Methods for conserving energy

   a. Landscaping to: (Transparency I-1-A, reduce radiation in summer, reduce air leakage, and reduce heat transmission loss)

      1) Use grass or other plant materials as ground cover to reduce air and surface temperature,

      2) Use dense shrubs (such as viburnum) close to a building to block wind and reduce air movement,

      3) Shade air conditioning units with shrubs or trees,

      4) Use vines or trees to cover walls and some windows,

      5) Use deciduous trees to shade buildings in summer (they let light in in the winter), and

      6) Use rows of evergreens, fences, walls or other buildings to break the wind, which controls its speed and direction.

b. Insulate building to recommended R-values (Houses in Louisiana need an R-value of 30 in ceilings, 18 in walls, and 19 on floors). 5

   1) Major types of insulation (Transparency I-1-B)

      a) Batts -- glass fiber, rock wool

      b) Blankets -- glass fiber, rock wool

      c) Foamed-in-place -- expanded urethane

      d) Rigid board -- polystyrene, expanded urethane, glass fiber

      e) Loose fill -- blown in -- glass fiber, rock wool, cellulose

      f) Loose fill -- poured in -- glass fiber, rock wool, cellulose, vermiculite, perlite

   2) Weatherstripping and caulking

      a) Around windows

      b) Doors

      c) Other openings

c. Lighting conservation

   1) Use fluorescent lighting where possible

   2) Turn off incandenscent lights when leaving an area for more than a few minutes

d. Machinery use

   1) Maintain at peak operating level.

   2) Keep tires properly inflated.

   3) Keep cutting edges sharpened.

   4) Remove unnecessary weight.

   5) Keep all filters clean.

6) Refrain from performing field operations on wet ground.

7) Make only necessary trips over the field.

8) Plan marketing so only full loads leave the farm.

e. Alternate energy sources

1) Solar energy can be used on the farm for:

   a) Space heating,

   b) Processing heat,

   c) Product and crop drying, and

   d) Electricity applications.

2) Wind from windmill can be used.

   Several windmills with storage batteries can provide a major portion of the electrical needs.

f. Fertilizer conservation

1) Soil test -- do not apply more nitrogen fertilizer than is needed for the crop being grown in that soil area.

2) Use a nitrogen fertilizer that is high in N -- this means less weight to carry over the fields.

g. Drying crops

1) Use solar power to dry,

2) Use ventilation in bins to lower drying costs,

3) Dry crops in the field or naturally when feasible, and

4) Plant early.

h. Use of Water

1) Insulate water heaters and hot water pipes.

2) Use natural slope in irrigation to save on pumping cost and energy use.

3) Use solar power and heat given off by milk cooling in order to warm water for dairy operation.

C. Suggested Student Activities

1. Make list of energy waste at home and on the farm.

2. Diagram the home and farmstead and show how landscaping can conserve energy in each specific case.

3. Accept the President's FFA Energy "Challenge."

D. Study Questions

1. Why is energy important to the farmer?

2. Since it is very warm in Louisiana, why do we need insulation?

3. What is R-value?

4. List three ways plants can help conserve energy.

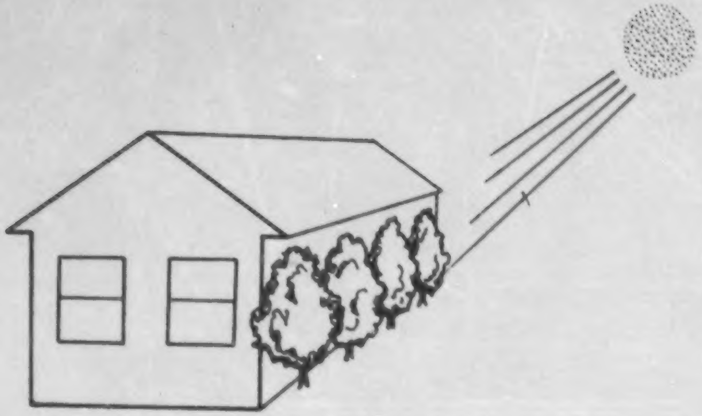
5. List three ways plants help consume energy.

6. What is solar energy?

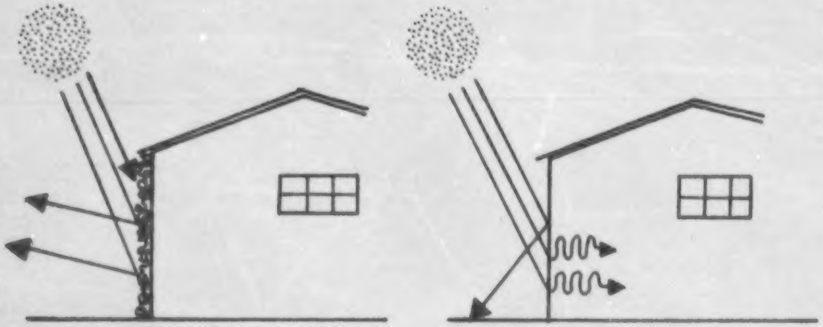
7. Name five fuels used on the farm?

8. What is heat radiation?

9. What is energy conservation?

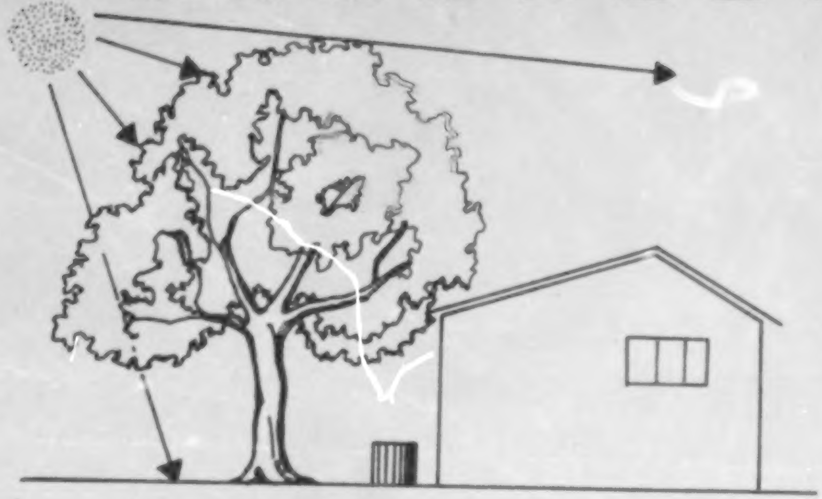


A DENSE SHRUB PLANTING HELPS SAVE ENERGY

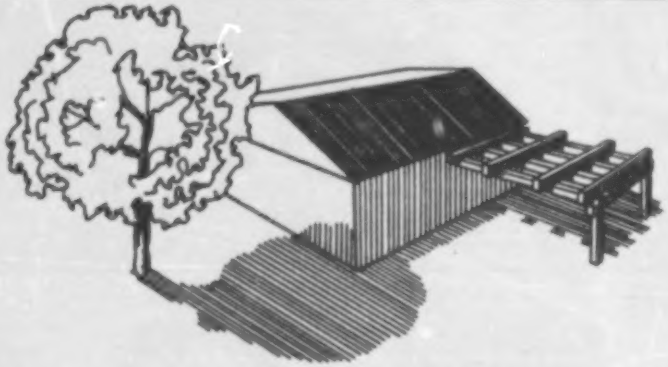


PLANTS TRAINED ON A WALL MODERATE INDOOR AIR TEMPERATURE

Transparency I-i-A

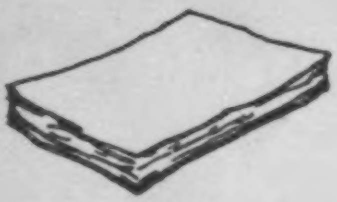


AN AIR CONDITIONING UNIT ON A SOUTH OR WEST WALL SHOULD BE PROTECTED FROM THE SUN

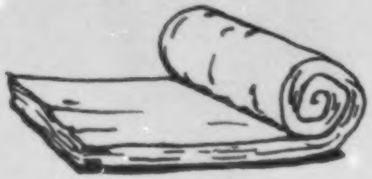


USE A TRELLIS TO REDUCE PENETRATING SUNLIGHT AND TO PROVIDE AN OUTDOOR AREA WITH SHADE. A DECIDUOUS VINE PROVIDES A SOLID OVERHANG IN SUMMER AND A MORE OPEN EFFECT IN WINTER

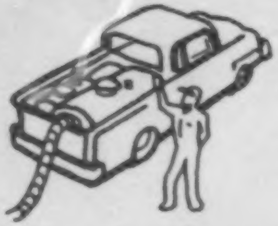
BATTS - GLASS FIBER, ROCK WOOL



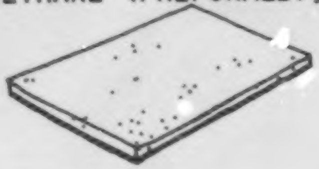
BLANKETS - GLASS FIBER, ROCK WOOK



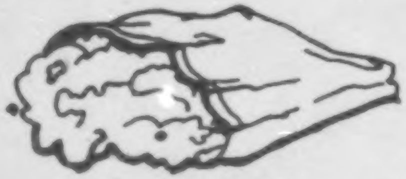
FOAMED-IN-PLACE - EXPANDED URETHANE



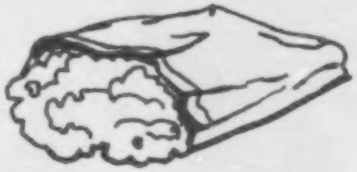
RIGID BOARD - POLYSTYRENE (EXTRUDED), EXPANDED URETHANE (PREFORMED), GLASS FIBER, POLYSTYRENE (MOLDED BEADS)



LOOSE FILL (BLOWN-IN) - GLASS FIBER, ROCK WOOL, CELLULOSE



LOOSE FILL (POURED-IN) - FLASS FIBER, ROCK WOOL CELLULOSE, VERMICULITE, PERLITE



TRANSPARENCY I-I-B

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT I: Orientation

LESSON 1: Introduction to Agricultural Mechanics, the Use of References, and Field Trips to the Shop Program.

I. Preparation for Instruction

A. Objectives

1. Terminal: Discuss the vital role of agricultural mechanics in society and the vocational agricultural program.

2. Specific:

a. Define agricultural mechanics.
b. Discuss the relationship between food and fiber and agricultural machinery.
c. Explain why agricultural machinery is becoming more highly sophisticated.
d. List six reasons for having mechanical knowledge and skills.
e. List the areas of concern in agricultural mechanics.
f. Discuss the different types of jobs in the field of agricultural mechanics.
g. Discuss the relationship between agricultural mechanics and one's supervised occupational experience programs.
h. List the individual areas of study in an agricultural mechanics program.
i. Describe the importance of agricultural mechanics in developing mechanical skills.
j.

k.

l.

B. Review Teaching Materials

1. Phipps, Floyd J. Mechanics in Agriculture. Danville, Ill.: The Interstate Printers and Publishers, Inc., 1967.

2. Phipps, Floyd J. Handbook on Agricultural Education in Public Schools. Danville, Ill.: The Interstate Printers and Publishers, Inc., 1965. 2

3. Vocational Instructional Services, Texas A&M, Agriculture Mechanics Unit A Topic 1.

C. Special Arrangements

1. Materials

   a. Pictures of old and new farm machinery

   b. Pictures of farm machinery that show equipment out of calibration or adjustment

   c. Pictures of the many and varied jobs associated with agricultural mechanics

2. Travel

   Student visits to local operations in the community which are related to the field of agricultural mechanics.

3. Audiovisual

   Overhead projector/transparencies

II. Presentation of Lesson and Suggested Student Activities

A. Motivation

1. A person employed or self-employed in agriculture cannot be a success unless he possesses considerable mechanical knowledge and skill.

2. Agricultural engineers estimate that approximately 85 percent of the machinery in operation on farms is more or less out of adjustment.

3. Agricultural mechanics is not just shopwork but also includes repair to agricultural machinery, construction of buildings and conveniences, maintenance of electrical equipment, and selection, management, operation, and maintenance of gas and diesel engines.

B. Content Outline

1. Terms

   Agricultural mechanics -- includes all the unspecialized mechanical activities performed on the farm and in agriculturally oriented business services; also

   refers to the operation and maintenance of machines and equipment used in industry and the varied mechanical jobs that people perform.

   To some individuals agricultural mechanics may be incorrectly referred to as farm mechanics, agriculture shop, farm shop, and shop.

2. Food and Fiber

   Agriculture must produce food and fiber to meet increasing world population needs. This involves field machinery and a wide range of farmstead systems providing efficient, labor-saving production.

3. As agricultural machines and systems become more complex, the need for qualified specialists will grow. A new generation of highly sophisticated equipment is being developed for modern, mechanized farming operations. Manufacturers need specialists to fill positions in sales, service, and educational programs. Mechanical knowledge and skills are very important because one can:

   a. Save the labor cost (50 percent of the total cost) on a needed project or repair job.

   b. Make project or construction plans and figure materials needed.

   c. Learn a skill by doing and be better prepared to use the proper tools and equipment for the job.

   d. Save time on a job that requires immediate attention.

   e. Build projects needed for the supervised experience program.

f. Make dependable judgments regarding machinery adjustments and needed repairs.

g. Recognize quality work on any type of agricultural mechanics project and demonstrate pride in good workmanship.

h. Make estimates as to the cost of construction and repair jobs.

i. Help other students and friends on mechanical problems. Be able to demonstrate shop skills.

j. Adjust to mechanical problems that arise after graduation.

k. Develop a home shop for the purpose of constructing needed projects and making repairs

l. Form habits of neatness, industry, accuracy, and carefulness.

m. Serve as a good unspecialized mechanic, not as a specialist or expert. Commercial shops are equipped to perform specialized jobs, such as a complete tractor overhaul.

4. The five areas of concern in agricultural mechanics, as set forth by the American Society of Agricultural Engineers (ASAE), are: (Transparency I-1-A)

    a. Power and Machinery -- Mobile power units, field equipment, and farmstead systems,

    b. Soil and Water -- Irrigation, drainage, erosion control, and utilization of water resources,

    c. Structures and Environment -- Structures, livestock, and plant environments,

    d. Electric Power and Processing -- Electrical energy utilization and feed processing for improved agricultural operations, and

e. Food Engineering -- Food product processing, storage, packaging, and handling. 5

5. Agricultural mechanization specialists work with products or services in the following areas:

   a. Agricultural machinery,

   b. Soil conservation practices,

   c. Farmstead planning,

   d. Electrical power applications,

   e. Building construction,

   f. Crop processing equipment, and

   g. Food and feed processing plus handling systems.

6. Listed below are occupations and skills that may be required of the trainee:

   a. Ranch employee
      Concrete construction
      Feed equipment repair and operation
      Fencing
      Carpentry
      Welding
      Use of hand power tools

   b. Horticulture employee
      Greenhouse humidifier operation
      Tree injector operation
      Tractor and equipment skills
      Turf plugger and sweeper operation
      Use of hand power tools

   c. Swine employee
      Feed equipment repair and operation
      Concrete construction
      Carpentry
      Use of hand power tools

   d. Fertilizer employee
      Operating and maintaining fertilizer equipment
      Tractor and fertilizer utilization
      Machinery for handling, mixing, and distribution of fertilizer

e. Agricultural machinery mechanic, Helper and Repairman 6
Farm power equipment, maintenance, and repair.

7. Mechanical knowledge and some skill in the use of equipment are helpful in each of the following trainee occupations:

   a. Horse farm employee,

   b. Poultry farm worker,

   c. Dairy farm worker,

   d. Poultry processing plant employee,

   e. Forestry employee,

   f. Wildlife conservation employee,

   g. Wool and mohair warehouse employee,

   h. Meat processing plant employee,

   i. Milk processing plant employee,

   j. Irrigation equipment sales,

   k. Agricultural chemical sales,

   l. Feed sales and serviceman,

   m. Feedlot employee,

   n. Cotton ginning employee, and

   o. Crop farm employee.

8. Agricultural mechanics instruction should be closely related to a student's supervised experience program. For example:

   a. A beef cattle project with an improved pasture requires the "know how" to operate, adjust, maintain, and repair tractors, plows, fertilizer spreaders, mowers, hay balers, seeders, and hauling machinery.

   b. It requires skill in carpentry, plumbing, concrete work, and electricity in order to repair and construct equipment and facilities for the cow herd and pasture.

c. If broilers are the supervised farming program, a brooder, feeders, and pens will be needed, all of which may be constructed in the vocational agriculture shop.

7. The individual areas of study in an agricultural mechanics program should include (but not be limited to) the following:

    a. Shop orientation and safety -- Information regarding shop behavior and safety rules orients the individual to proper conduct in the shop.

    b. Tool identification -- Identification of tools allows students to work efficiently by knowing what common tools will do different jobs.

    c. Farm carpentry -- Carpentry instruction introduces the worker to uses of power and hand tools, basic construction procedures, and safety measures.

    d. Cold metal work -- Metal work includes use of tools, cutting, drilling, tapping, and threading of metal for farm use.

    e. Hot metal work -- Instruction in shaping and bending metals under heat with proper tools is demonstrated.

    f. Conditioning and the proper use of hand tools -- Tool instruction allows one to correctly identify, select, use, and maintain hand tools.

    g. Proper and safe use of power tools -- Power tool instruction demonstrates use and safety of shop power tools commonly used.

    h. Concrete -- Subject areas concerning uses of cement in basic building construction as well as basic block or brick construction are included in this shop area.

i. Plumbing -- Information is given regarding plumbing fixtures, their repair, and common household plumbing systems. Also included are pipe use and identification as well as selection of equipment and supplies.

j. Farm electricity -- This shop area deals with planning a wiring system, techniques of maintaining and repairing electrical equipment, and safety.

k. Agricultural power-small gas engines -- Small engine repair and maintenance are covered in this shop area including tool use and parts identification and use.

l. Tractor maintenance -- Tractor maintenance is essential to efficient and economical operation. Important information includes subjects such as record keeping, preventive maintenance practices, and service procedures.

m. Farm water supply and sanitation -- Location and construction of wells and septic tanks are taught in this shop area.

n. Use of the farm level -- Use of the farm level is covered by instruction on determining slope, terrace or contour lines, and the level of a building foundation for construction purposes.

8. The agricultural mechanics shop is considered a very important laboratory for learning mechanical skills. Students will be graded on how well they perform the assigned shop skills, the type of workmanship they exhibit on their projects, and how closely they adhere to the shop rules and regulations.

C. Student Activities

1. Each student should be able to write the definition of agricultural mechanics and list the five areas of concern.

2. Each student should make a list of the different areas of agricultural mechanics

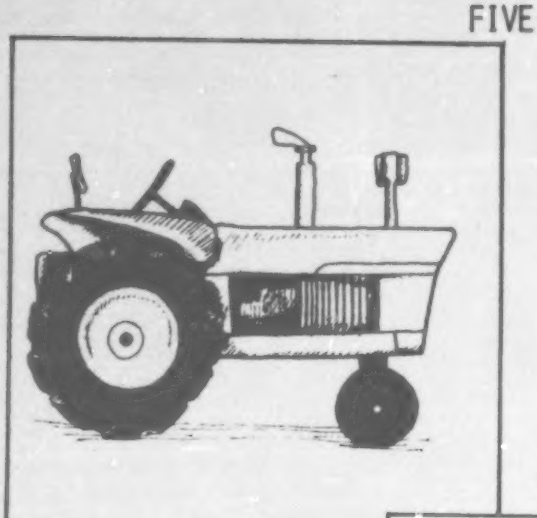
involved in his or her supervised farming program.

3. Have students compare the new type of agricultural machinery to that of 25 years ago.

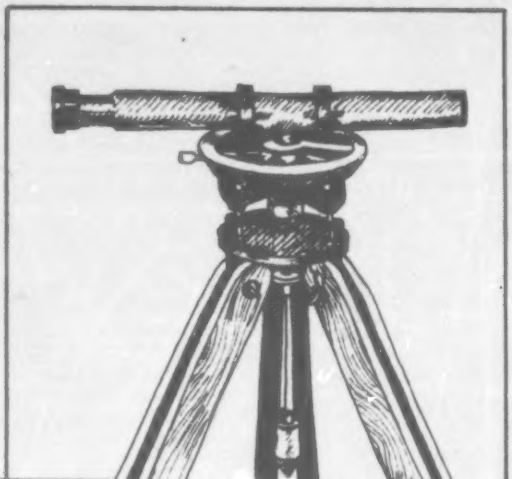
4. Have students make a list of all the different types of agricultural mechanical jobs and businesses located in the community.

5. Plan a class tour to acquaint the students with the shop working areas and equipment.

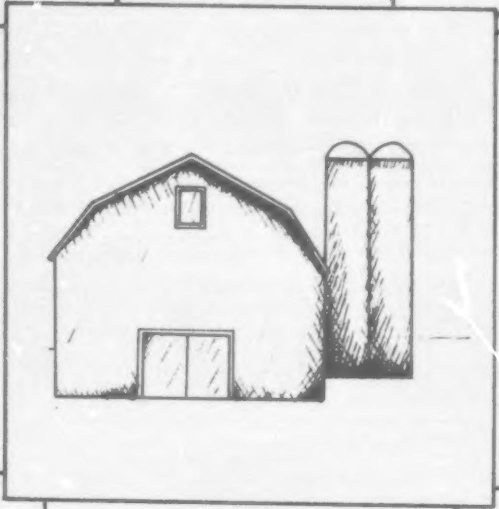
FIVE ASAE DIVISIONS



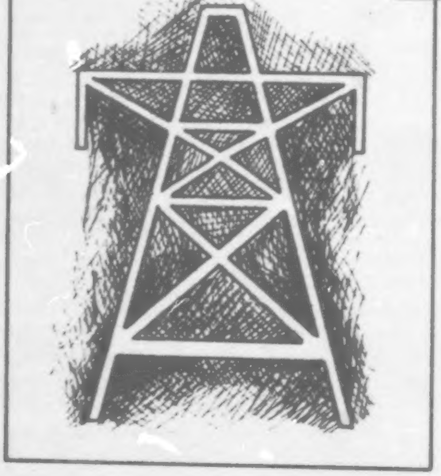
POWER AND MACHINERY - MOBILE POWER UNITS, FIELD EQUIPMENT AND FARMSTEAD SYSTEMS.



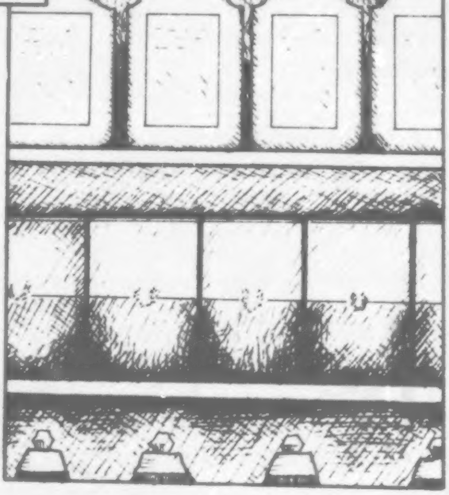
SOIL AND WATER - IRRIGATION, DRAINAGE, EROSION CONTROL AND UTILIZATION OF WATER RESOURCES.



STRUCTURES AND ENVIRONMENT - STRUCTURES, LIVESTOCK AND PLANT ENVIRONMENTS.



ELECTRIC POWER AND PROCESSING - ELECTRICAL ENERGY UTILIZATION AND FEED PROCESSING FOR IMPROVED AGRICULTURAL OPERATIONS.



FOOD ENGINEERING - FOOD PRODUCT PROCESSING, STORAGE, PACKAGING AND HANDLING.

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT I: Orientation

LESSON 2: Safety Measures

I. Preparation for Instruction

A. Objectives

1. Terminal: Demonstrate safety procedures in the school's agriculture shop.

2 Specific:

a. Explain the importance of shop safety rules and regulations.
b. Demonstrate safety awareness by conducting a hazard hunt.
c. Explain how to prepare for safety before entering the work area.
d. Discuss how to prepare for safety on entering the work area.
e. Describe safety practices at the work station.
f. Identify the meaning of various colors used in color coding a shop.
g. List safety steps to check before leaving the shop at the end of the day.
h.

i.

j.

B. Review Teaching Material

1. Phipps, Lloyd J. Mechanics in Agriculture. Danville, Ill.: The Interstate Printers and Publishers, Inc., 1967.

2. Jacobs, Clinton O. Developing Shop Safety Skills. Athens, Ga.: The American Association for Vocational Instructional Materials, 1979.

3. Vocational Instruction Service, Texas A&M, Ag. Mech Unit A, Topic 2

C. Special Arrangements

1. Materials

a. Lay out some broken or defective tools

b. Brochures, posters, and bulletins on safety

2. Travel

Students visit a local community establishment which operates a shop and talk to the shop foremen to obtain their views on shop safety.

3. Audiovisual

Overhead projector/transparencies

II. Presentation of Lesson and Suggested Student Activities

A. Motivation

1. It is estimated that over 90 percent of all shop accidents are caused by a factor which can be called "human error."

2. Work accidents are disabling more than 2,000,000 persons each year. Of these, 80,000 were permanently disabled and 12,500 died.

3. The cost of these injuries accounts for billions of dollars lost in wages and medical, legal, and disability payments. The pain and suffering to the individuals involved are immeasurable.

B. Content Outline

1. The purposes of shop rules are:
    a. To protect the learner while a skill is being learned. (Transparency I-2-A)
    b. To protect expensive equipment and hand tools. (Transparency I-2-B and C)
    c. To keep tools and equipment available and in condition for teaching skills. (Transparency I-2-D)
    d. To develop skills by using the tools and equipment properly.
    e. To learn to respect properly conditioned tools and equipment and good workmanship.
    f. To develop skills by drawing shop plans, figuring bills of materials, budgeting time, buying building materials, and constructing projects.
    g. To develop a shop-type of behavior.
    h. To learn to appreciate the value of good housekeeping practices.
    i. To prepare and keep a good notebook and records.
    j. To have a thorough understanding of the agricultural mechanics program.
2. Heading the list of shop accidents is the "position and actions of people." Simply having hands, feet, or body in the wrong position and using the wrong actions accounted for 44 percent of the accidents. Improper use of tools, machines, and protective equipment were causes of 40 percent of the injuries. Lack of skill and using incorrect procedures accounted for another 11 percent. (Transparency I-2-E and F)
3. Each person is responsible. The way one feels toward safety is the most important safeguard against injury. One must be constantly aware of the dangers that exist and the possibility of accidents to oneself

and others. Then, out of respect - not fear - accidents do not just happen, they are caused. (Transparency I-2-G) 13

Failure to provide for safety may result in the following problems:

a. Pain to the victim,

b. Liability,

c. Loss of time,

d. Loss of money, and

e. Possible guilt.

4. There are five human factors which contribute to shop safety. They are as follows:

   a. Knowledge: A large number of shop accidents can be attributed to the lack of knowledge. Lacking proper instruction, receiving the wrong instruction, or obtaining the wrong information are all obstacles to safety. To become skilled in shop safety, one must learn:

      1) To recognize a hazard,

      2) To reduce or avoid the hazard,

      3) To know how to handle or control the hazard, and

      4) To avoid creating hazards for nearby workers or students or whoever follows.

   b. Skill: Knowing the hazards of the job is not enough. It is necessary that one knows how to follow proper procedures when using hand and power tools. To become skillful, a person must have the desire and receive the proper instruction and practice.

      Modern tools and machines are designed with safety of the operator in mind. Learning how to use tools safely is one's responsibility.

c. Physical ability: One's physical ability to handle shop tools and machines may have an effect upon how safely one can work. It is important that the worker knows the limitation of his/her physical ability. 14

d. Positive attitude: Tools and machines cannot think. The operator must be a person who has a positive attitude and safe working habits. A safe worker has the attributes of being concerned, alert, careful, cool, attentive, and responsible.

   1) How does shop safety save time and money? More accidents happen in the home than anywhere else. Many of these accidents are shop related. When one member of the family is hurt, the entire family is affected. Time is lost, income may be cut off, and medical bills must be paid.

      It has been estimated that about 2 billion dollars are lost each year as a result of farm work accidents. Much of this work is shop related.

      Because of accidents in school shops, where training is most important, students lose nearly one school day per injury. Thus, prevention of accidents does save time and money.

   2) How does shop safety encourage pride and satisfaction? A clean shop that is a well organized shop with a minimum of safety hazards provides the skilled worker with an ideal place to work. In such an environment, one has a feeling of pride, security, and well-being. Certainly, safe working conditions will encourage the development of safe working habits. The satisfaction one gains helps establish the mental framework for working safely in the shop.

No matter how skillful the operator, a portable power tool or machine tool that is out of adjustment or unsuitable for the job will not perform properly. Worn, dull, broken, or defective tools also contribute to accidents. A safe worker will recognize the poor condition and discontinue the job rather than apply force or permit others to use a defective tool or machine or improper equipment.

Safety guards and devices are provided with power tools. They should be operating properly.

e. Supervision: It is wise never to work alone or out of calling distance of someone. Persons who are unfamiliar with a task should have supervision. Never leave students without supervision.

5. Preparing for safety before entering the shop. There are certain tools, machines, and equipment that must be provided in advance of each job. Plan by thinking ahead. For example, if one plans to tune a car engine, one requires certain specifications, tools, machines, and materials are. Also, for this job one must guard against such hazards as getting burned on a hot engine or hit by a moving fan blade.

   a. Determine what tools, machines, and materials are required: Take a look at the job one plans to do and list the necessary tools, machines, and materials.

      1) Decide what one is going to do.

      2) Study one's plans.

      3) Prepare a bill of materials.

      4) Make a list of tools and machines needed.

b. Determine what hazards are involved:

    1) One type of hazard is the potential danger of the job itself or physical hazards involved.

    2) The other is the possibility of something going wrong.

        a) Protect eyes from flying objects,

        b) Protect lungs from paint, dust, and dangerous chemicals, and

        c) Watch out for falling objects.

    3) From their knowledge of the tools, machines, and materials to be used and the surroundings, students will make a list of the hazards that should be considered.

c. Determine what skills are needed: Take a look at the plans. Consider the tools one is going to use. Read the service manual. To become skilled in safe shop work, a person must be able to answer "yes" to the following questions:

    1) Do you understand the procedures?

    2) Are the tools, machines, and materials available?

    3) Are you skilled in the use of the tools and machines?

    4) Can you apply safety skills?

    5) Will you follow directions?

    6) Are you aware of the hazards involved?

    7) Are you prepared for emergencies?

d. Determine proper clothing and safety equipment. (Transparency I-2-H) Safety equipment should provide protection from normal hazards. When things go wrong and the unexpected happens, safety equipment should help prevent injury. A person should be able to identify the clothing and safety equipment recommended for various types of jobs. They are:

1) Types of clothing suitable for shop work,

2) Types of foot and leg covering,

3) Types of head covering,

4) Types of eye and face protection,

5) Types of hand and arm protection,

6) Types of hearing protection, and

7) Types of lung and breathing protection.

The clothing to be worn in doing any shop work should be made of a fabric which will be durable, fire resistant, and comfortable. Clothing which is torn, frayed, or soiled from petroleum products is a hazard. Clean, well-fitted and maintained clothing is a must. A loose piece of clothing, such as a necktie, is a hazard that could cause very serious injury or death.

6. Preparing for safety on entering the shop: A person's primary concern in a shop is to protect self and others. One should be able to locate and name the general safety provisions to be found in a shop. They are:

   a. Exits -- Emergencies may occur which will make it necessary for one to leave the shop immediately. On entering the shop, locate all exits so that all workers can leave quickly if necessary.

   b. Emergency fire equipment -- Upon entering the shop, look for the fire extinguishers and fire alarms. They should be in a conspicuous and accessible place. (Transparency I-2-I)

c. Emergency aids -- A portable first-aid kit should be provided to apply simple aid to minor cuts, abrasions, and burns. It is usually located in a wall cabinet designated by a green cross. Eyewash bottles and fountains are usually supplied at the first-aid station and in the immediate area where hazards may exist, including such work areas as welding, soldering, painting, and masonry. (Transparency I-2-J)

d. Main power disconnect -- The electrical service has been provided with a main disconnect switch to all electric powdered tools and machines. Its purpose is to provide a push button for rapid emergency disconnect for all equipment except lights.

e. Safety zones and lanes -- Movement of people and materials through a shop is greatly improved if a shop is kept clean and safe traffic lanes and zones are marked and kept open. Each piece of power equipment requires floor area in which an operator can successfully move without obstruction. Traffic lanes to exit doors and through the shop are a safety requirement. Look around, observe potential hazards, and correct those that can be corrected. Report those hazards that were not corrected.

7. Preparing for safety at the work station:

a. As a skillful shop worker, one must take as much pride in the use, care, and maintenance of the tools and machines one works with as the quality of the work which one produces. To apply skills, the worker must have tools and machines of the proper type and condition. Proceed as follows:

   1) Remember where the tool came from so that it can be placed back in the original location.

2) Follow established procedures for obtaining tools. If tools are to be assigned or signed out, do not violate this rule.

3) Check condition of tool upon receipt. If the tool needs repair, tell the supervisor or see that the tool is repaired before use.

4) Use care in handling tools.

b. Safety precautions to be observed at the work station. They are discussed under the following headings:

1) Guarding floor openings and storage areas,

2) Providing for proper lighting,

3) Checking for proper ventilation,

4) Checking for caution areas and protective signs, and

5) Checking for guard rails.

c. Electricity may be supplied in three different voltages. It is important that a person be able to identify the outlets for each voltage. Power tools and machines are designed to operate on only a specific voltage. Serious damage and fire can result if one uses the incorrect voltage.

d. Compressed air is used for operating portable air tools for spray painting and cleaning. Use a "safety-blow" nozzle for cleaning with compressed air. This reduces the discharge pressure so that it won't be more than 30 psi. See to it that hoses are equipped with quick attach couplings. Take care when removing them from the supply line. They can slip out of your hands and cause a whipping action which could strike like a snake. Check for damaged hose and connections. Do not turn air pressure toward others or toward your skin.

e. Hydraulic power is most commonly used in jacks. Hydraulic jacks are not dangerous from the extremely high fluid pressure because it is contained inside the steel jack. There is a danger of using a jack that is too small for the job. Also, remember that jacking is for raising heavy loads, not holding them. Always use jack stands. 20

f. In shop work one will need to use solvents and chemicals for cleaning, painting, and gluing. A person must understand that these materials can be very toxic and flammable. Avoid contact with the skin and inhalation of fumes.

8. Understanding the color code: Color is used in many school and industrial shops as a method of increasing safe working conditions. Color affects the visual senses of the mind and can reduce stress and general fatigue. Study the safety colors in the shop or work area and learn what they mean. (Transparency I-2-J)

9. Preparing to leave the work area: Always leave the shop in a clean and orderly condition. A clean shop not only looks attractive, but it is much safer for all who use it. (Transparency I-2-K)

   a. Check the check list:

      1) Store hand and power tools,

      2) Secure stationary power tools,

      3) Store welding equipment,

      4) Store usable materials and supplies,

      5) Dispose of scrap metal, filings, and chips,

      6) Dispose of hot metal,

      7) Dispose of waste liquids,

      8) Dispose of sawdust and absorbent compounds,

9) Dispose of scrap lumber,

10) Clean the workbench and floor,

11) Store safety equipment, and

12) Do personal clean-up.

b. It is a good safety practice to let the following thoughts run through one's mind as check-off items for securing the shop.

1) Is the lid closed on the parts-cleaning solvent tank?

2) Are the air hoses uncoupled and stored?

3) Are traffic lanes open?

4) Are fire extinguishers accessible?

5) Are waste cans properly covered?

6) Can one hear any machines running? (Are they turned off and unplugged or disconnected?)

7) Are extension cords properly stored?

8) Are ventilating or exhaust fans turned off?

9) Are tool cabinets locked?

10) Are windows closed and locked?

11) Are security lights on?
Lights out?

12) Is electric power locked off?

13) Doors locked?

C. Student Activities

1. Have the students discuss personal shop-related accidents that have happened to them or someone they know. List the reason(s) why the accident occurred and how it could have been prevented.

2. Students should identify why it is important to protect themselves as well as others. 22

3. List the five human factors which contribute to shop safety.

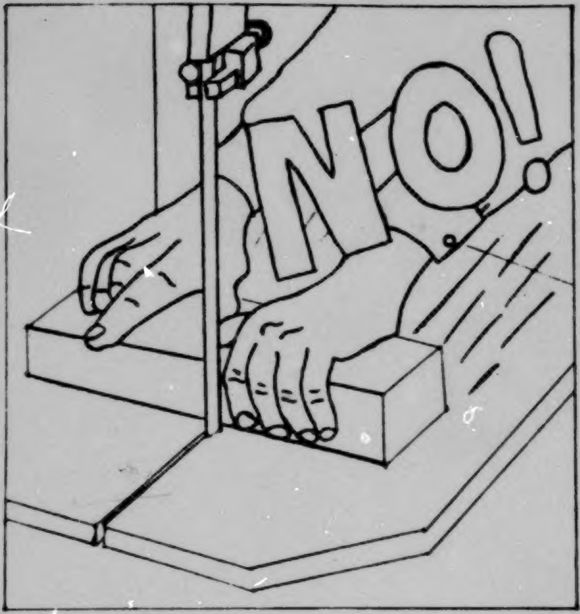
4. Describe what causes the largest percentage of accidents.

5. Have the students make a safety check of their homes (preferably a home shop) to list any potentially dangerous situations.

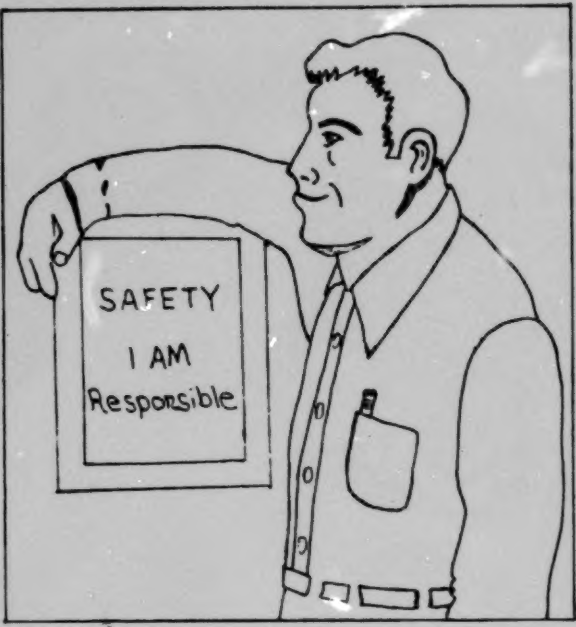
6. Write how shop safety saves time and money.

7. Make a diagram showing the equipment placement with the safety rules and precautions for each.

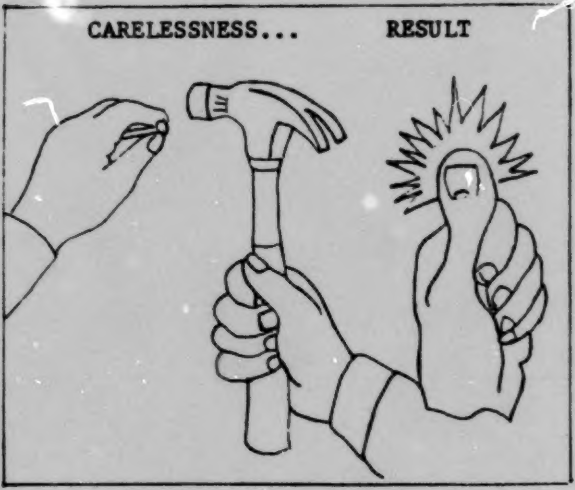
SHOP SAFETY



MOST ACCIDENTS ARE CAUSED BY UNSAFE ACTIONS OF INDIVIDUALS


SAFETY
I AM
Responsible

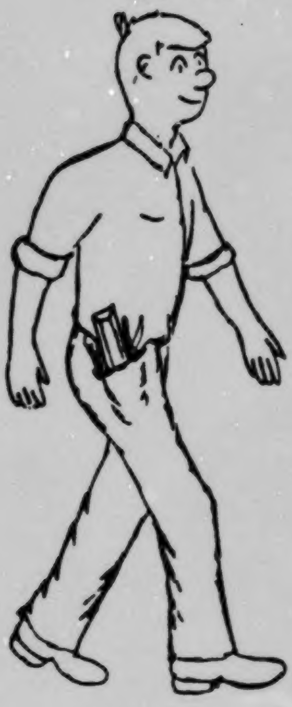
YOU ARE RESPONSIBLE FOR THE SAFETY OF YOURSELF AND OTHERS


CARELESSNESS...
RESULT

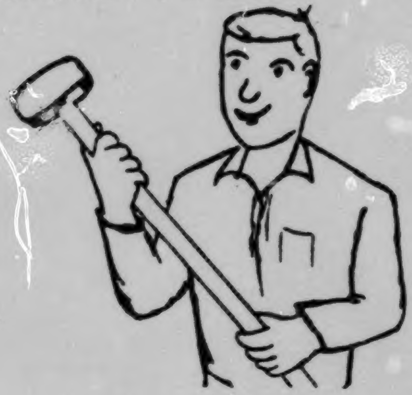
CARELESSNES + HAZARD = ACCIDENT

TRANSPARENCY I-2-A

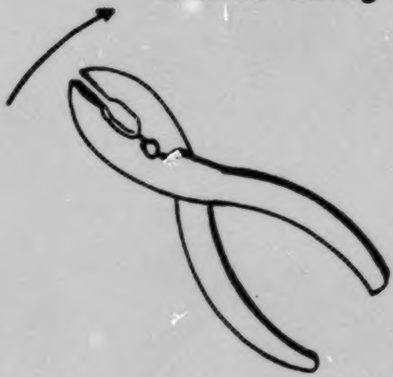
SHOP SAFETY HAND TOOLS



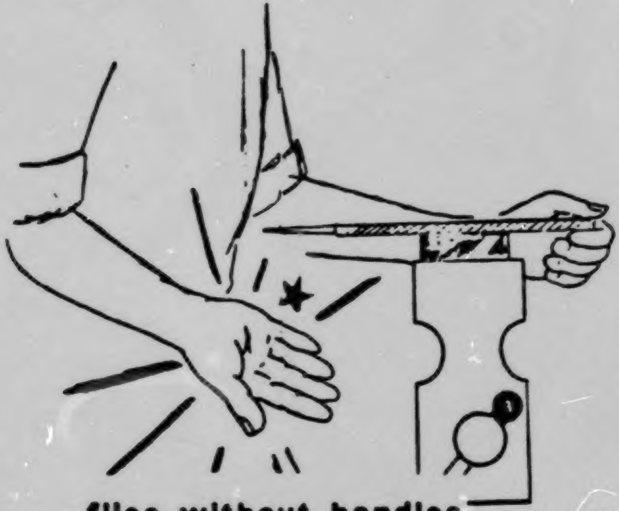
sharp edge tools carried in pockets are very dangerous



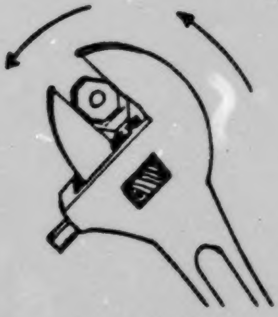
handles are checked before using tool



worn tools cause hand injuries



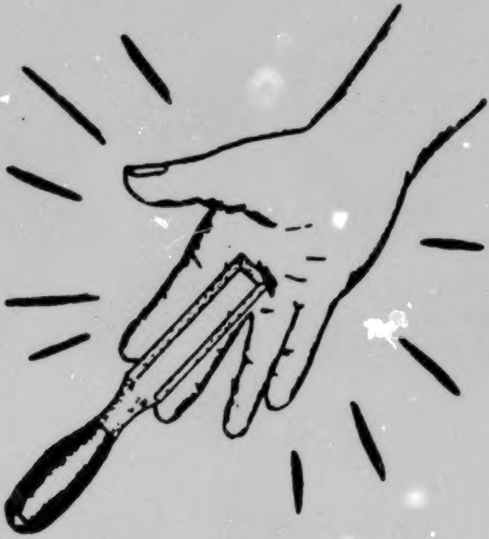
files without handles are dangerous shop tools



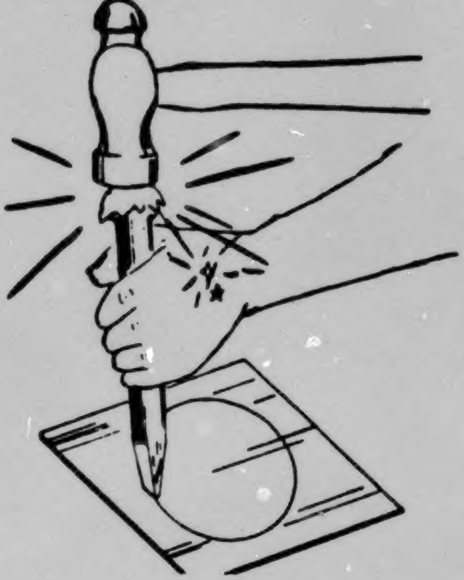
wrench used improperly may break causing injury

TRANSPARENCY I-2-B

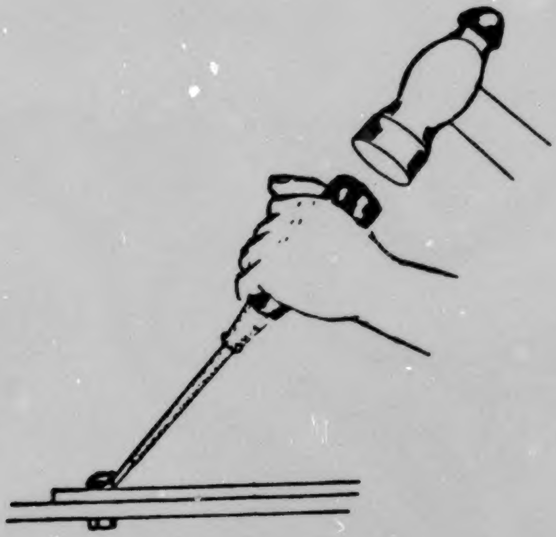
SHOP SAFETY HAND TOOLS



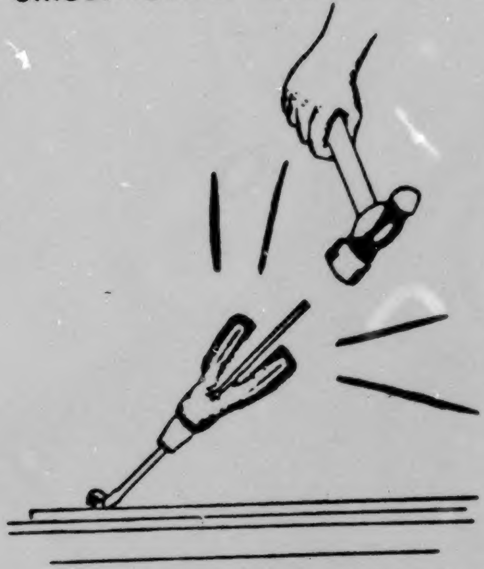
dull wood chisel slips causing injury



mushroom head cold chisel--silver causes injury



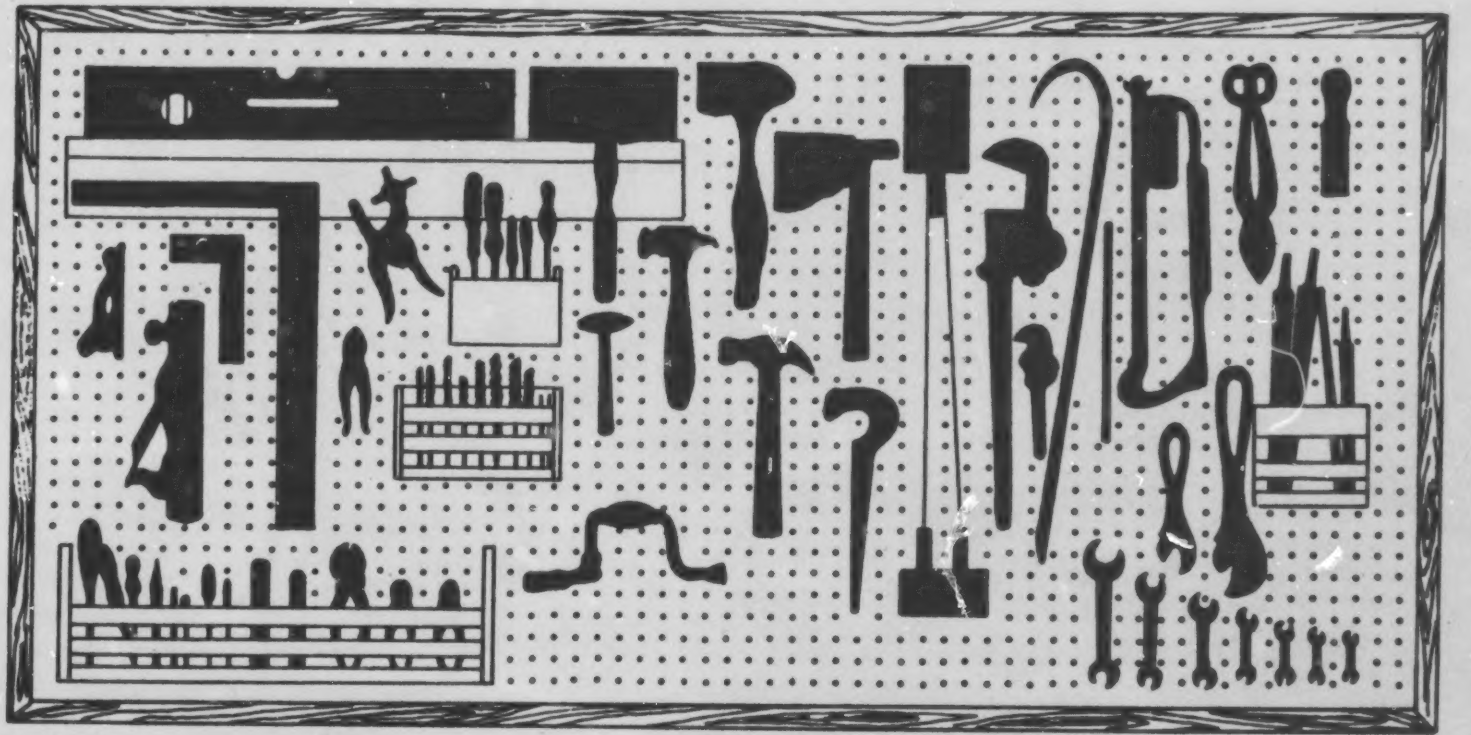
improper use of hand tool can cause injury



possible injury to body by improper tool use

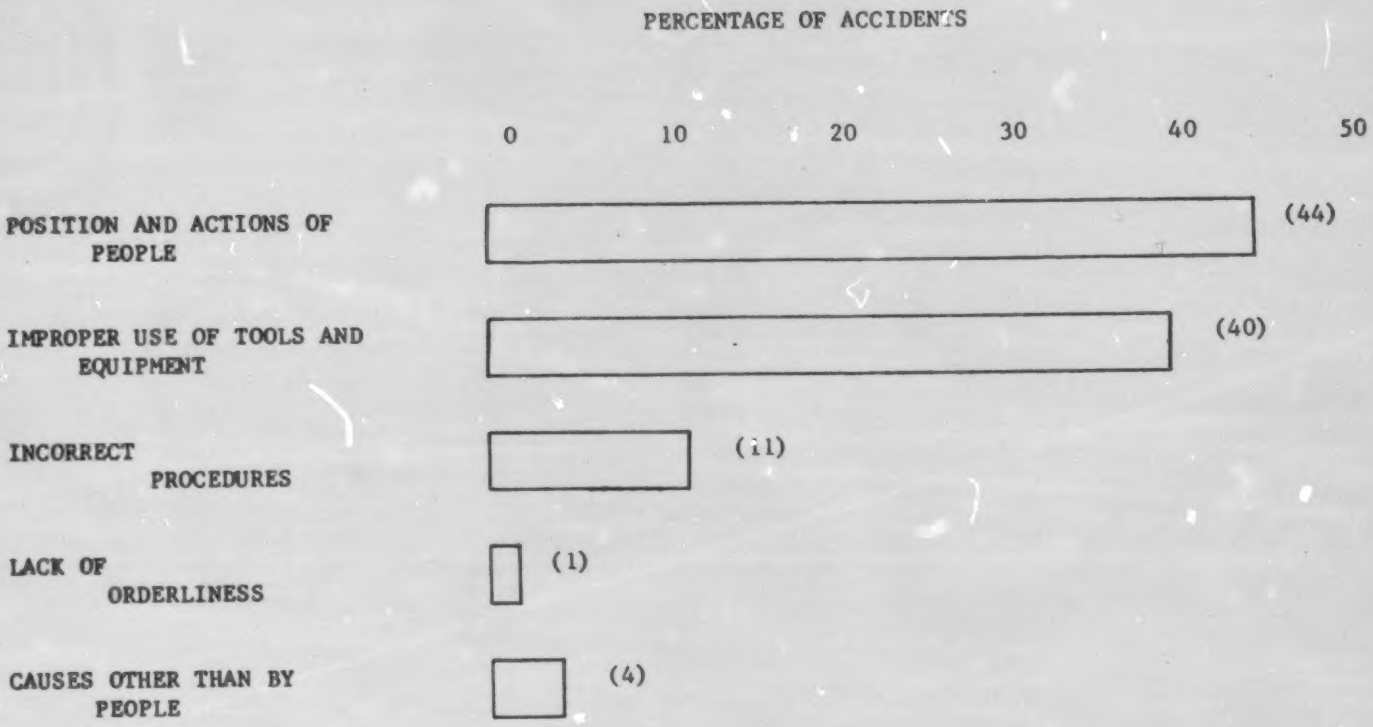
TRANSPARENCY I-2-C

SHOP SAFETY



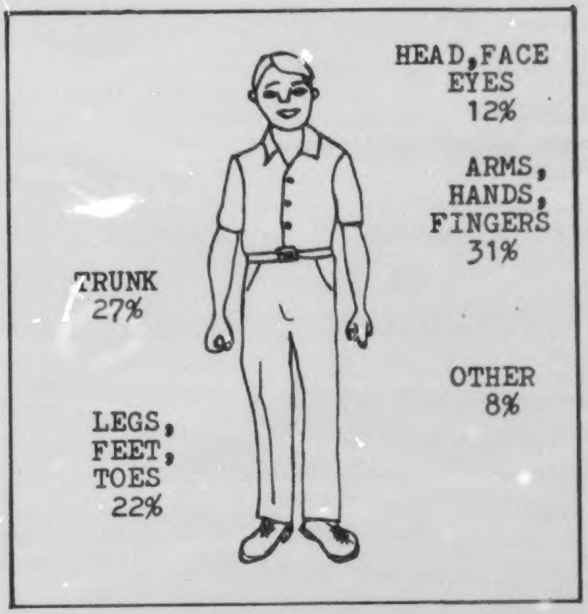
TOOLS IN PROPER PLACE

TRANSPARENCY I-2-D

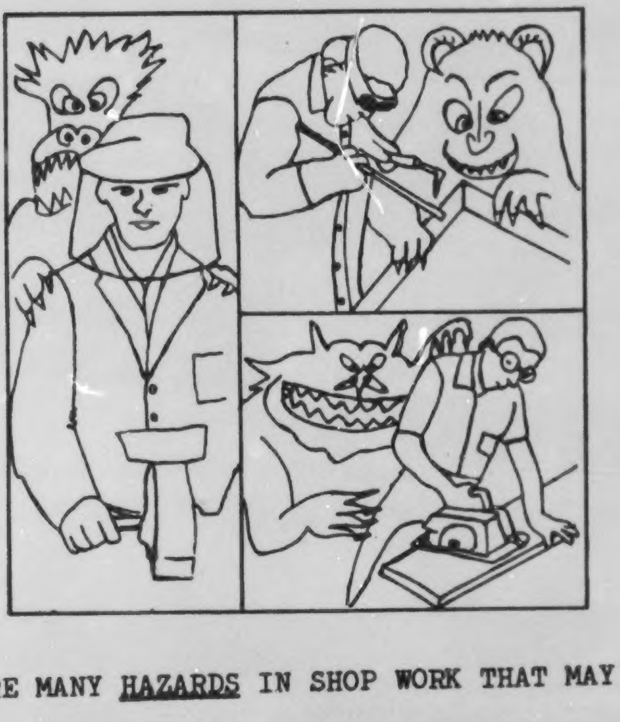


TRANSPARENCY I-2-E

PERCENTAGES OF BODILY INJURY

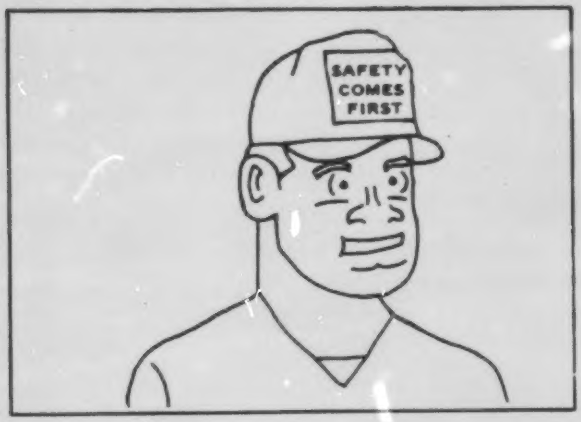


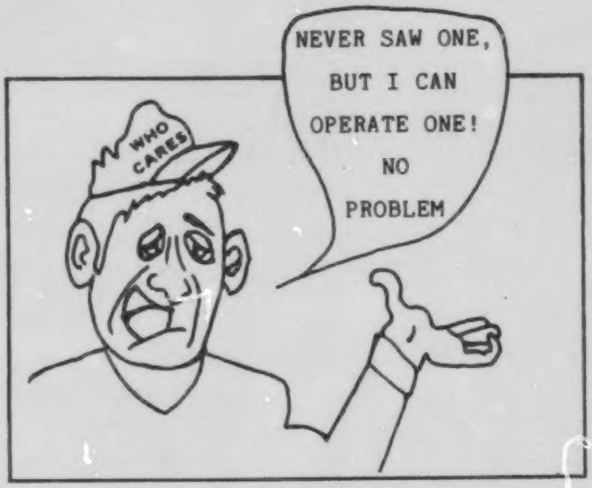
PARTS OF BODY INJURED IN WORK ACCIDENTS



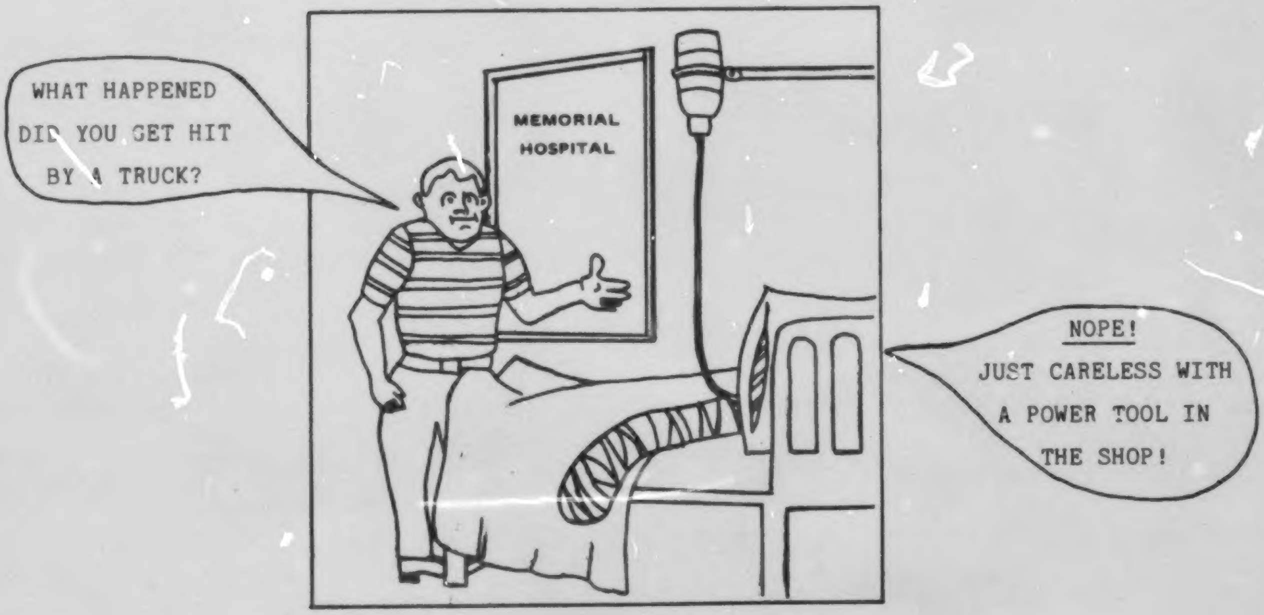
THERE ARE MANY HAZARDS IN SHOP WORK THAT MAY CAUSE INJURY

TRANSPARENCY I-2-F


SAFETY COMES FIRST

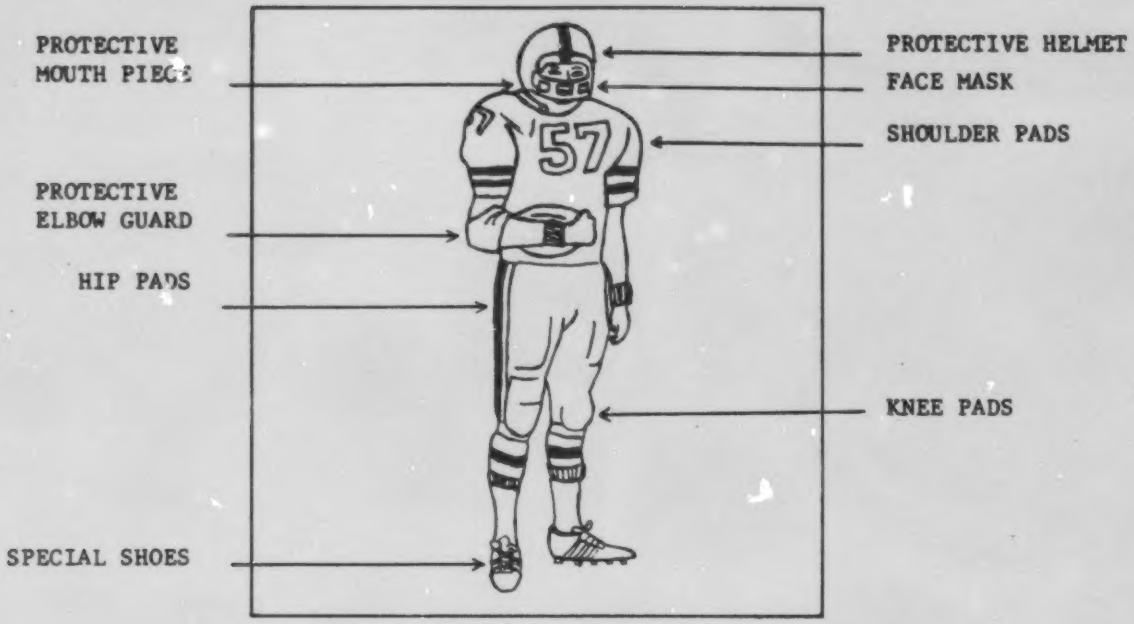

WHO CARES
NEVER SAW ONE, BUT I CAN OPERATE ONE! NO PROBLEM

Develop a positive attitude
toward developing safety habits

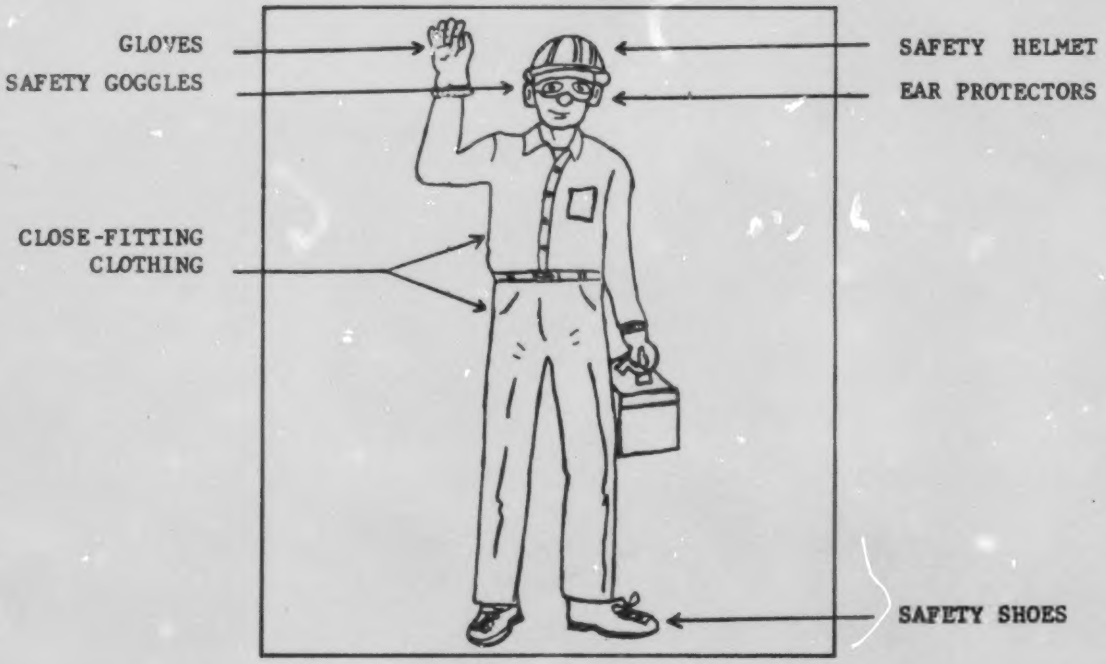

WHAT HAPPENED DID YOU GET HIT BY A TRUCK?
MEMORIAL HOSPITAL
NOPE! JUST CARELESS WITH A POWER TOOL IN THE SHOP!

TRANSPARENCY I-2-G

PREPARED FOR ACTION


PROTECTIVE MOUTH PIECE
PROTECTIVE HELMET
FACE MASK
SHOULDER PADS
PROTECTIVE ELBOW GUARD
HIP PADS
KNEE PADS
SPECIAL SHOES
57

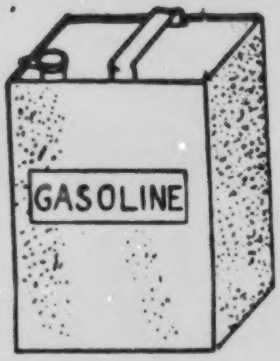
THIS IS A PROFFESSIONAL WHO IS PREPARED FOR ACTION


GLOVES
SAFETY GOGGLES
SAFETY HELMET
EAR PROTECTORS
CLOSE-FITTING CLOTHING
SAFETY SHOES

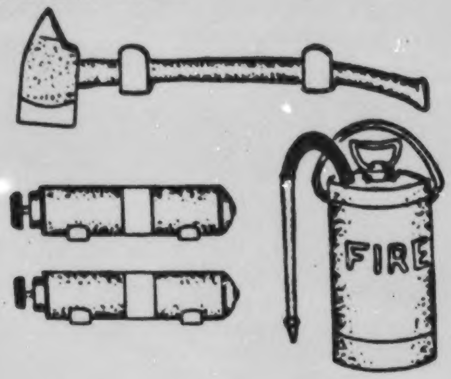
THIS PROFESSIONAL IS PROPERLY PREPARED FOR SHOP WORK

TRANSPARENCY I-2-H

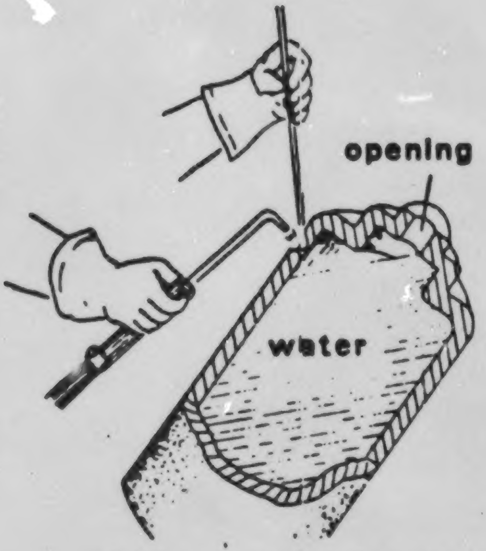
SHOP SAFETY
FIRE - EXPLOSIONS



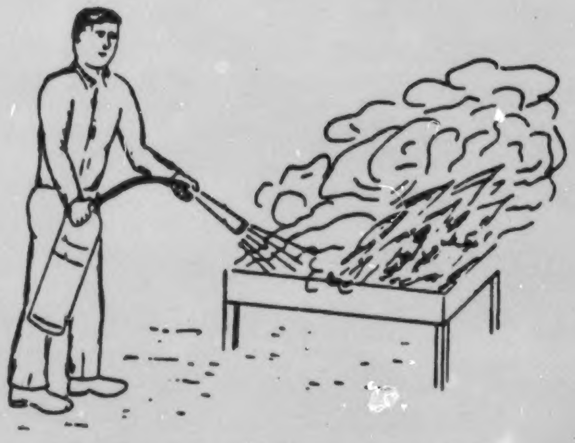
gasoline is not
a safe solvent



fire control equipment


opening
water

proper safety practice
for welding and
cutting containers



certain shop fires require
special fire chemicals

TRANSPARENCY I-2-I

SHOP SAFETY COLORS

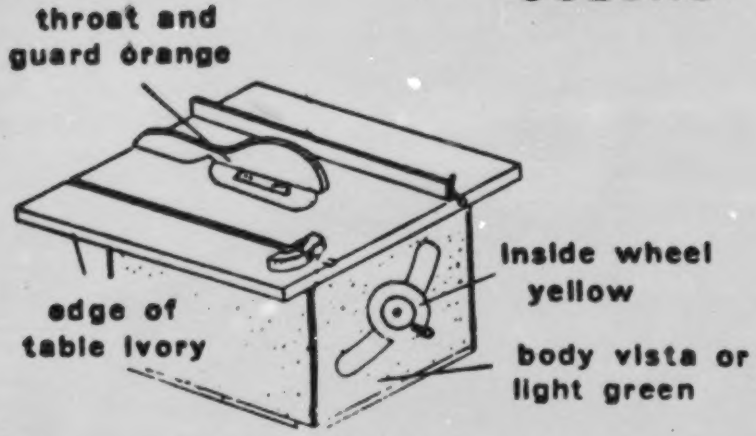
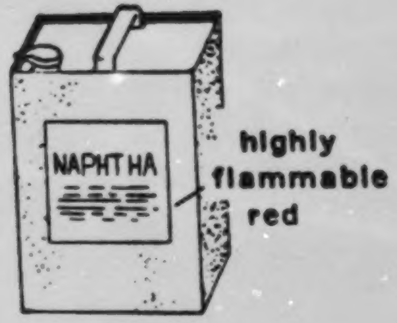
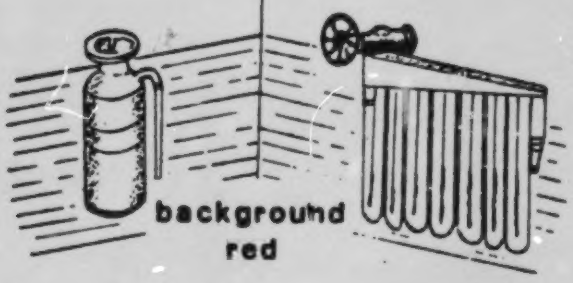

throat and guard orange
inside wheel yellow
edge of table ivory
body vista or light green

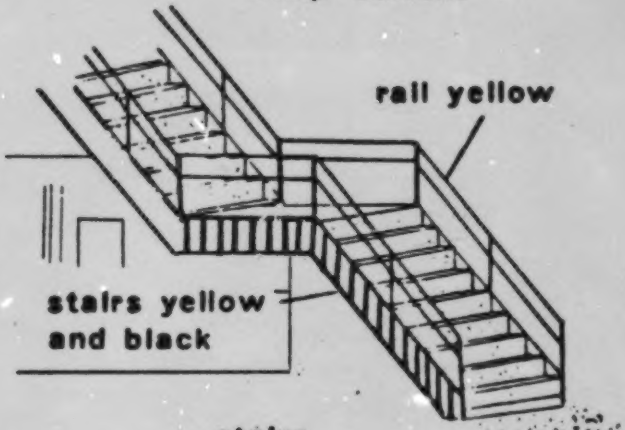
table saw


NAPHTHA
highly flammable red

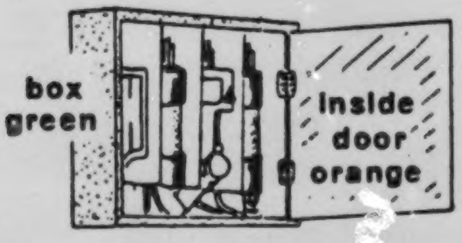
shop solvent


background red

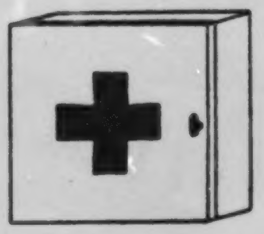
fire equipment


rail yellow
stairs yellow and black

stairs


box green
inside door orange

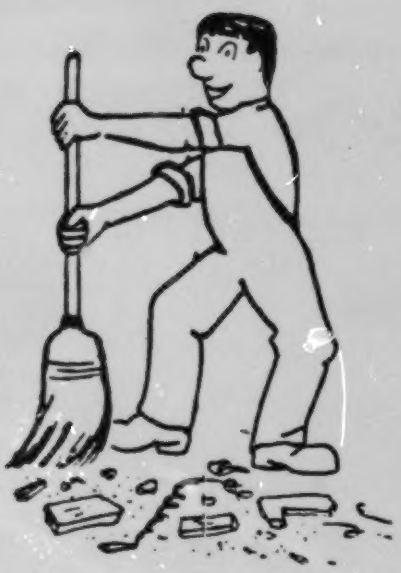
fuse box



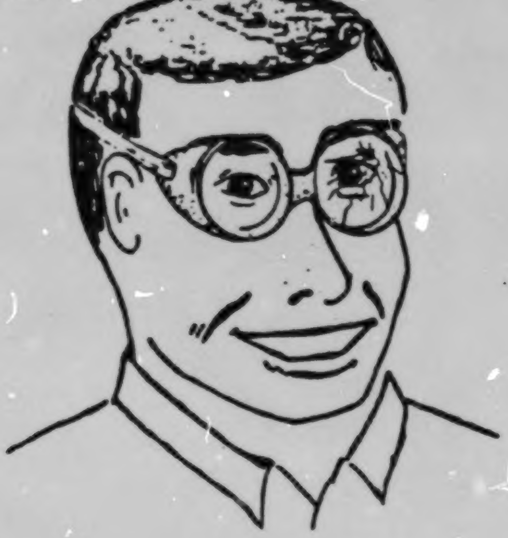
first aid safety green

Transparency I-2-J

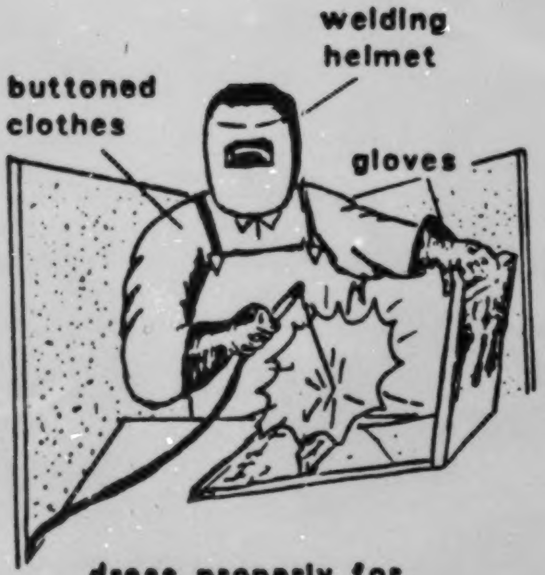
SHOP SAFETY



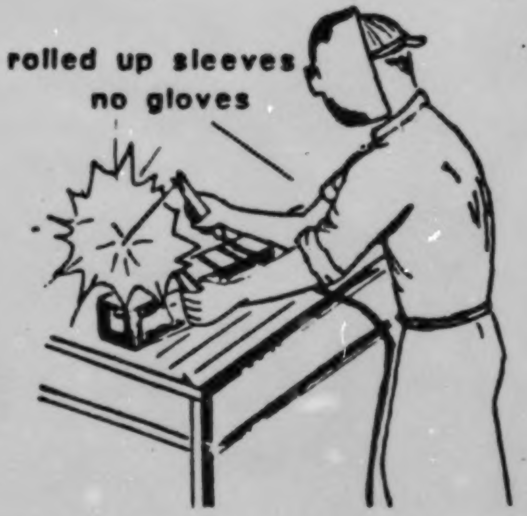
a clean shop is a safe shop



goggles protect the eyes
on some jobs


welding
helmet
buttoned
clothes
gloves

dress properly for
arc welding


rolled up sleeves
no gloves

improper dress may cause injury

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT I: Orientation

LESSON 3: Identification, Care, Storage, and Proper Use of Hand Woodworking Tools

I. Preparation for Instruction

A. Objectives

1. Terminal: Identify various common woodworking tools, their care, storage, and proper use, in the agricultural mechanics shop.

2. Specific:

a. Identify common woodworking tools found in the agricultural mechanics shop.
b. Contrast the different types of care and storage of various woodworking tools.
c. Describe how rust may be safely removed from tools.
d. Describe the three rules to remember to get the most out of your tools.
e. List the handtool safety rules.
f. Demonstrate the proper use of nail hammers.
g. Demonstrate the proper use of hand planes.
h. Demonstrate the proper use of hand saws.
i. Demonstrate the proper use of wood chisels.
j. Demonstrate the proper use of the brace and bit.
k. Demonstrate the proper use of hand drills.
l. Demonstrate the proper use of screwdrivers.
m. Demonstrate the proper use of measuring and marking instruments.
n.

o.

B. Review Teaching Materials

1. Phipps, Lloyd J. Mechanics in Agriculture. Danville, Ill.: The Interstate Printers and Publishers, Inc., 1967.

2. FOS Shop Tools. John Deere Fundamental Writing Service. Moline, Ill.: John Deere Co., 1980.

3. Vocational Instructional Services, Texas A&M, Agriculture Mechanics Unit B, Topics 1, 2, 3, 4, 5, 6, 7, and 10.

C. Special Arrangements

1. Materials

a. Various assortment of hand woodworking tools.

b. Hand woodworking tool charts, pictures, or manufacturers' catalogues.

2. Travel

Students visit local community woodworking shops

3. Audiovisual

Overhead projector/transparencies

II. Presentation of Lesson and Suggested Student Activities

A. Motivation

1. Each student will be required to build a woodworking shop project using only hand tools. In order to accomplish this, the student first must be able to identify, care for, store properly, and know the proper use of the tools involved with woodworking.

2. Learning all the "right ways" in which one utilizes woodworking tools will increase both efficiency and workmanship.

3. Tools are an extension of the craftsman's "right arm." It is imperative then, that the craftsman becomes knowledgeable as to the correct operating procedure and care of tools.

B. Content Outline

1. Every student should familiarize himself with the names of the different kinds of tools and their uses. Much of the success in agricultural mechanics depends upon the proper selection of tools and their proper use.

   Knowing how to care for tools is exceedingly important, since their usefulness depends to a large degree upon their care.

   a. Some precautions in the care of tools are as follows:

      1) Do not drop tools.

      2) Keep tools clean and free from rust.

      3) Keep tools sharp.

      4) Be careful not to bring the cutting edge in contact with metal, or nicking may result.

      5) Clean and put tools away in their proper places when through with them.

      6) Choose the proper tool. Do not expect a crosscut saw, for example, to rip satisfactorily.

   b. All grease on tools should be carefully removed with a soft material, or if necessary, by washing the tools with a safe cleaning solvent. Rust may be removed and prevented as follows:

      1) Apply cleaning solvent and let the tool sit for several hours

      2) Rub and polish with oil and pumice stone or with an emery cloth

      3) Apply a thin film of light oil to the surface of the tool before it is put away

2. Tools do not make the serviceman - but they help. Knowing how to use and care for them

will put one a step ahead of the crowd. To get the best out of tools, remember these three rules:

a. Purchase only good tools,

b. Keep tools in safe condition, and

c. Use the right tool for the job.

3. Tool Safety Rules:

a. Use right tool. Don't force small tools to do the job of a heavy-duty tool.

b. Maintain tools with care. Keep tools sharp or well-adjusted, cleaning them periodically. Be sure handles are securely fastened.

c. Use safety glasses with many tools. Also use a face or dust mask if a cutting operation is dusty.

d. Keep guards in place and in working order.

e. Keep children away. All shop visitors should be kept a safe distance from the work area.

f. Keep work area clean. Cluttered areas and benches invite accidents.

g. Store idle tools. When not in use, tools should be stored -- out of the way. Disconnect all power tools when not in use.

h. Wear proper apparel. Loose clothing can get caught in moving parts.

i. Secure work. Use clamps or a vise to hold work. It's safer than using one's hands as it frees both hands to operate the tool.

j. Don't force a tool. It will do the job better and safer at the rate for which it was designed.

k. Don't overreach. Keep proper footing and balance at all times.

l. Pull on wrenches - don't push. If one must push, use the base of the palm and hold hand open. This is a way to save knuckles.

m. Hold pointed tools away from the body. This will avoid possible injury if the tool slips.

n. Ground all power tools. Use a three-pronged plug or an adapter with wire attached to a known ground.

o. Have good lighting and ventilation. Be sure bench areas are well-lit and that exhaust fumes are drawn out of the shop.

p. Keep a first-aid kit handy. Treat all minor injuries at once to prevent infection.

4. Use of Nail Hammers:

a. Selecting nail hammers:

1) The most common nail hammer used in the agricultural mechanics shop is the curved claw hammer. The second most common hammer is known as the rip hammer or the straight claw hammer. (Transparency I-3-A)

2) The most common weights of nail hammers ranges from 13 to 20 ounces. A 16-ounce hammer is the most popular, and it is known as the standard hammer size. The size of the nail will determine the weight of hammer to select.

3) The claw hammer is used for driving and pulling nails. It is better for pulling than the rip hammer. Rip hammers are used mainly to dismantle or tear down structures made of wood and to drive nails.

b. Driving nails -- the following steps should be observed when driving nails: (Transparency I-3-B)

1) The hammer handle should be grasped near the end. Check the face to

see that it is clean, and check the handle for splinters and inset in the head. 28

2) Place the face of the hammer on the nail, then strike it with a light blow to start the nail. The nail should be held by the thumb and fingers near the nail head.

3) Deliver the remaining blows by putting the shoulder, elbow, and wrist into the action and striking the nail squarely on the head to prevent bending it and marring the wood.

4) The last blow or two should be lighter than the power blows in the center of the operation. This may prevent or eliminate hammer marks at the nail head.

c. Pulling nails -- the steps in pulling nails include:

1) Nails are pulled without damage to the hammer and the board by first slipping the claws under the nail head and raising the hammer handle until it is vertical.

2) Slip a block of wood under the head of the hammer while it is in the vertical position and continue pulling the nail unless there is too much strain on the handle.

3) It is better to pull a bent nail, caused by driving, and drive a new one in a new place.

4) If pulling the nail requires putting too much pressure on the hammer handle, a wrecking bar should be used instead.

d. Setting nails -- If casing, finish, or flooring nails are used it may be necessary to set the heads below the surface 1/16 of an inch by using a nail set. The set is braced by a lower finger and tapped lightly with the hammer. Nail sets range in size from 1/32" to 4/32" at the tip or point.

5. Use of a wrecking bar: The most common ripping or wrecking bar is 24 inches in length. It is a gooseneck for pulling nails and has a wedge-shaped, slightly bent end for prying loose boards. They can be found in sizes from 1 to 3 feet in length. Most wrecking bars are made of 3/4 inch octagon-shaped tempered steel.

A wrecking bar is necessary in pulling large nails, wrecking buildings, opening wood crates, and dismantling many kinds of wood structures.

6. Use of a Hand Plane:

a. Purposes:

1) Planing small and large pieces of boards to smooth the surface, either on the face, end, or edge.

2) Planing to straighten and smooth surfaces for joining boards by gluing.

3) Planing to correct the size or dimension of an object or piece of material. For example: doors can be fitted to the door frame by planing.

4) Planing to eliminate twists or crowns (high parts in the face of a board).

5) Hand planes are also used where jointers and planers are not available to smooth cut a board to a certain size, or to correct board defects.

b. Selecting the plane according to the job to be performed: (Transparency I-3-C)

1) Jack plane -- This plane is the most commonly used of the many types of hand planes. It is from

11½ to 15 inches long and is used mainly to smooth the surface by cutting with the grain. The most commonly used jack plane is 14 inches long with a 2 inch wide blade. 30

2) Smoothing plane -- A smoothing plane is from 5½ to 10 inches in length. It is used mainly for smoothing, surfacing, and finishing work. It can also be used to work end grain on boards. A plane 8 inches long with a 1 3/4 inch wide blade and is considered standard.

3) Block plane -- This plane is used for cutting end grain or working small pieces of materials. The average length of this plane is about 6 inches.

4) The fore and jointer planes -- These planes are used for straightening the edges of long pieces of material or wood objects. The fore plane is 18 inches long, and the jointer plane is 22 to 24 inches long. Both the fore and jointer planes are also used for smoothing edges.

5) Special planes -- The rabbet (for rabbeting edges), combination (for dadoing and grooving), and the circular plane (for planing concave or irregular surfaces) are of less importance to farm carpentry than the jack, smoothing, and block planes. Generally, special planes are used only for the finishing type of work. The duplex or full nose rabbet planes can be used to plane into corners. The most commonly used rabbet plane is 8 inches long with a ½ inch blade.

c. Assembling the jack, smoothing, fore, and jointer planes: (Transparency I-3-D)

1) The plane iron bevel (cutting edge) must be opposite the plane iron cap when the two are put together. It

is placed on the cap so that the curved part of the cap will not be dragged over the plane iron edge. 31

2) The plane iron cutting edge should protrude from 1/32 to 1/16 inch beyond the plane iron cap, or about one-half the thickness of the plane iron.

3) The plane iron assembly should be placed on the plane frog so that the plane iron lies on the frog and the lateral adjusting lever.

4) The lever cap is placed against the plane iron cap, the lever cap screw is fitted in the narrow part of the screw slot, and the cam is pushed down against the plane iron cap.

d. Adjusting the plane: (Transparency I-3-E)

1) With the plane held upside down, the protruding cutting edge (1/64 inch or the thickness of a sheet of paper) is adjusted evenly across the plane bottom. The entire blade should cut evenly.

2) The depth of cut should be made by turning the adjusting nut that is found in front of the handle. Plane iron setting (angle and depth) may be also made by placing two fingers on each side of the iron or protruding cutting edge.

3) The block plane is assembled and adjusted in a similar manner as the jack plane except there is no plane iron cap attachment.

e. Proper use of the hand plane: (Transparency I-3-F and G)

1) Holding the board or stock -- The board may be placed in a bench vise for edge planing, or a V-shaped block may be used to hold it securely.

2) A board may be held for face planing by nailing a stop block to the table or by clamping a stop block firmly to a work table.

3) The board should be held so that face and edge planing is accomplished by pushing the plane with the grain of the wood.

4) Making the plane stroke -- One hand is placed on the handle and the other on the knob, and the plane is placed on the board at the back of the area to be cut before any pressure is applied in making the stroke.

5) At the beginning of the stroke, pressure is applied on the knob; near the middle of the stroke the pressure should be the same on both front and back of the plane; and at the end of the stroke the pressure should be on the handle of the plane.

6) The plane can be lifted slightly, the heel lifted slightly, or the plane tilted to prevent dragging the blade over the surface on the return stroke. When not in use, the plane should be laid on its side.

7) Strokes made by a block plane are short. It is used in one hand with the forefinger placed on the finger rest.

7. Hand Saws:

a. Types:

1) Crosscut saw -- The crosscut saw is the most commonly used of all hand saws for general farm work. Teeth on this saw are shaped to cut across the grain of wood. From perpendicular, the front of the tooth is 15 degrees and the back 45 degrees. The most commonly used crosscut saws have from 8 to 11

teeth per inch of blade. The length of blade varies from 18 to 26 inches. The longest blade is the most popular. Fast and coarse cuts are made with a small number of teeth to the inch. Ten and 11 point saws are used to cut finishing materials such as moldings and door facings. (Transparency I-3-H)

2) Rip saw -- This saw is used to cut with the grain. The overall angle of rip saw teeth are the same as those of a crosscut saw, but the forward angle is only 8 degrees from perpendicular. Teeth cutting edges are square, and the back angles are 52 degrees. The most popular sizes are 24 to 26 inch blades with 5½ to 7 teeth per inch.

3) Compass saw -- This saw is used to cut curves and circles, starting a cut from a hole bored by a brace and bit, and to cut holes for pipe outlets. The blades taper from back to front. Compass saw blades are 12 to 14 inches in length with 8 teeth to the inch. The shape of the teeth resembles those on a crosscut saw. (Transparency I-3-I)

4) Keyhole saw -- The keyhole saw is used to saw "cutouts." It may be found as a single blade saw or a nest of saws (one handle with two or three replacement blades). One of the blades is used for cutting metal. This saw resembles the compass saw, but the standard blades range from 10 to 20 inches with 10 to 15 points per inch. Curves, holes, and straight sawing cuts are usually smoother when done with a keyhole saw than with a compass saw.

5) Coping saw -- This saw is designed to cut thin or light wood. It is used to cut curves, for scroll work, and for shaping the ends of moldings. Blades of this saw are

about 1/8 inch wide and are made of thin metal. The overall length may vary from about 6½ to 7 inches with 15 points to the inch.

6) Backsaw -- Backsaws are used to make accurate and smooth cuts. The large backsaw is known as a mitre box saw. They may range in length from about 22 to 30 inches. The width of the reinforced blade varies from 4 to 6 inches. Small backsaws are found in lengths from 10 to 16 inches, and the number of teeth per inch may vary from about 11 to 15. All backsaws and dovetail saws are reinforced the full length and down the back edge of the blade.

b. Proper use of the different types of handsaws:

1) Crosscut saws

a) Assuming the material is on a sawhorse or in a vise, grip the saw handle and place the index finger forward on the handle.

b) Place the free hand in a position on the material to be sawed so that the thumb can serve as a guide for starting the blade.

c) Hold the saw blade so that it is at a right angle to the stock and the saw cutting edge is 45 degrees to the surface being cut.

d) Start the saw cut by placing it on the waste side of the line and use draw strokes until a starting groove is formed. Maintain the 45 degree angle and take long even strokes as the saw cuts through the stock. If pressure is applied, it should be on the downward stroke.

2) Ripsaw

   a) Use the same procedure when sawing with a ripsaw except for changing the angle to 60 degrees.

   b) If the saw is pinched when ripping a long board, use a wedge to spread the pieces apart.

3) Compass and keyhole saws

   a) After the stock has been marked, start the cut by either a light forward or backward motion.

   b) Hold the saw in the proper position. For example, if the cut is to be square, the saw blade must be held perpendicular to the stock.

   c) To cut a hole or cut an area out in a stock, first bore a hole and start the cut in the hole.

   d) Cut curves and holes by slightly twisting the handle in the direction of the cut.

   e) When sawing sharp curves and small holes, use the point or pointed part of the saw blade.

4) Coping saw

   a) Check the blade to determine whether or not the teeth are pointing toward the handle and the blade has proper tension. The blade is more likely to kink if it is inserted to cut on the forward stroke.

   b) Hold the stock firmly in a vise, bracket, or saddle in order to make a smooth cut.

c) Turn the blade in the frame to keep the frame from touching the stock. Usually a quarter of a turn is adequate.

d) Make long, steady, slow strokes. Fast strokes tend to heat the blade and increase the possibility of kinks.

e) Release the tension on the blade when the saw is no longer used.

5) Backsaw

a) Start the backsaw cut in the same manner as a crosscut and ripsaw cut; that is, pull the saw backwards to make the initial cut.

b) If the saw is used out of the mitre box, the thumb may be used to guide the blade on the line until the saw begins cutting the stock on the forward stroke.

c) When using a mitre box to cut in either a 90 or 45 degree direction, place the stock in the box nearest the body and use the free hand to hold the stock. The thumb of the free hand is not used to guide the blade, but the index finger is placed along the side of the handle.

8. Selection and use of wood chisels and mallets:

a. Description -- Wood chisels are selected according to the type of work that is to be performed. Naturally, a 3/4 inch dado work will require a chisel larger than 1/4 inch and smaller than 7/8 inches. A 1/2 to 5/8 inch chisel will permit working room for notching out and smoothing the 3/4 inch dado surface. (Transparency I-3-J)

Wood chisel sizes vary from 1/8 to 2 inches. The length of blade ranges from about 3 to 6 inches. Long lengths are called firmer chisels. Medium lengths are called pocket chisels. Short lengths are called butt chisels.

b. Socket chisels -- This is the most common type of chisel used in farm carpentry. Because the handle is fitted into a steel socket, the chisel can withstand harder blows from the mallet. These chisels are used for rough woodwork and framing. The most common sizes are 3/8, 3/4, and 1½ inch.

c. Tang chisel -- The handle of a tang chisel is similiar to that of the socket chisel except that the tang is fitted into the handle. Less driving pressure should be applied to the tang chisel than to the socket chisel. Tang chisels are better for hand work, such as paring, because of their light weight and balance. The tang of a chisel is the spike-like or file-like handle part of the chisel fitted into the handle. This type of chisel usually has a plastic handle.

d. Steps in making a cut with a wood chisel: (Transparency I-3-K)

   1) The board to be worked should be fastened firmly. A vise is the best method to use for short wood stock.

   2) The chisel cut should be made with the grain to prevent the board from splintering or splitting.

   3) One hand should be used to guide the chisel blade, and the other hand should be moved slightly from right to left as pressure is applied to the chisel handle.

   4) The bevel should face down when making rough cuts, and it should be face up when paring or finishing materials.

5) The first cut over a surface may require the use of a mallet, whereas the finishing cut of the same work should be done by hand. This method of chisel cutting is used mainly for making joints.

e. Care of the chisel while in use:

1) The chisel should be laid on a table with the bevel down to protect the cutting edge.

2) The wood chisel should be kept sharp and the cutting edge protected from all metal.

3) A chisel, like all other tools, has a certain purpose and should be used for that purpose. It must not be used to pry open containers, used as a screwdriver, and the hammer should never replace the mallet to drive the chisel.

9. Selection and use of the brace:

a. Description -- Braces range in size from about 6 to 14 inches. The size is determined by the brace swing or sweep, that is, the distance across the diameter of the circle made by a complete sweep of the handle. A 10 inch sweep brace is most commonly used to do average work. (Transparency I-3-L)

The ordinary brace without the ratchet may cost less than the ratchet brace, but its functions are limited. The ratchet permits the boring of holes in places where a full handle turn cannot be made because of obstructing objects. The ratchet works both ways, forcing the bit forward or backward. It can also be set so that the handle will not swing free in the operation.

Corner braces are equipped with two handles and a head. It is used for boring against walls and in corners.

b. Selection of the more common types of bits: (Transparency I-3-M)

1) The auger bit is used for boring holes in wood. The tang on the shank is usually square, depending on the type of brace used. Auger bits range in size from 3/16 inch to about 2 inches. A No. 11 bit will bore a hole 11/16 inch in diameter. The figure 11 is found on the shank.

2) The expansive bit is used to bore holes ranging from 1 to 3 inches in diameter. The blade or cutter may be adjusted for different sizes of holes. The expansive bit is similar to the auger bit in that it has a feed screw that draws the bit into the wood. It has only one lip; therefore, it must be held straight.

3) The Forstner bit is also used on wood. It can be used to bore holes for dowel pins and to countersink washers that are used with bolts on wood. The sizes range from ¼ inch to 2 inches in diameter.

4) The twist drill bit, which is sharpened with the same angle as the round shank bit for metal, is used for both metal and wood boring. The more pointed bit stock or twist drill is used for wood only. The sizes may range from 1/16 inch to 1¼ inches in diameter.

5) Screwdriver bits are used to set or loosen screws or bolts with slotted heads. The size is determined by the width of the bit blade. The widths range from 3/16 inch to more than 1/2 inch.

6) Countersinks are used to widen the space at the hole entrance for oval or flat head bolts or screws. The head of the screw or bolt is set

flush or slightly below the 40
surface. The size is determined by the diameter of the cut made by the largest part of the bit.

7) Gimlet bits are used to make holes for screws in wood. The bit point forms the tapered hole. They vary in size from 1/8 inch to 3/8 inch in 1/32 increments.

c. How to start the hole by using the brace and bit -- steps in starting the auger bit include: (Transparencies I-3-N and O)

1) Mark the location of the hole center by crossed lines.

2) Start the hole with a sharp pointed tool (awl or ice pick).

3) Grasp the lower part of the bit (twist) and place the hand against the board; at the same time insert the point of the bit into the hole at an angle.

4) Raise the bit until it is at a right angle with the work.

5) Test to see that the hole is being bored squarely by:

a) Sighting the bit at right angles,

b) Comparing the bit with the nearest straight edge: The sides of the bench vise that holds the material may be used as a straight edge, and

c) Using a try square near the bit.

d) Boring the Hole:

(1) Pressure is applied by one hand when boring a vertical hole. Usually, the

left hand is used to put pressure on the head of the brace. 41

(2) When boring a horizontal hole, place the left hand over the brace head and the thumb and forefinger around the quill. The stomach puts pressure against the left hand.

10. Types of drills operated by hand and their purposes: (Transparency I-3-P)

a. Description -- Hand drill purposes include -- Drilling small holes, either in wood or metal, ¼ inch or less in diameter.

Form holes or openings for screws, nails, bolts, and other materials where openings are necessary.

Push drills are used mainly to bore holes for small screws in wood and other soft materials. A push drill is made to bore a hole less than 1/4 inch in size. Most push drills have a set of bits ranging from 1/16 to 11/16 in size stored in the handle. This drill may be operated by one hand while the other hand is left free to support the work.

Breast drills are designed for heavier work than either hand or push drills. They are usually constructed with adjustable handles and two speeds. The drill is made to bore a hole up to ½ inch. The breast drill is for general purpose work in metal and wood.

b. Proper use of a hand drill: (Transparency I-3-Q)

1) The hand drill should be held firm and steady while in use, regardless of the angle it is used on the work.

2) The handle of the hand drill may be held against the body, releasing the hands for the crank and side handles. This is the way a breast drill is used.

3) The handle of the hand drill may be held against the body, releasing the hands for the crank and side handles. The crank should be turned at a steady speed and not too fast.

4) The push drill is used with one hand placed on top of the handle. The return spring causes the drill to unwind on the backward stroke, which helps clean the hole and forces the bit into a cutting position. (Transparency I-3-R)

c. Steps to follow when drilling a hole are:

1) The center of the hole should be marked with an awl or similar tool for drilling soft materials and with a center punch for metals.

2) A drill bit of the proper size should be selected (the diameter of the cutting part may be slightly smaller than the large part of the screw or bolt for soft materials, and it should be the same size for metal materials).

3) The stock being drilled should be held firmly, either in a vise or by other means.

4) On metal, a drop or two of oil should be used at the place of drilling.

5) The pressure should be eased as the drill breaks through the surface.

6) A small pilot hole made by a small bit is necessary in forcing a larger bit through certain woods or metals.

7) To drill to a certain depth, make a depth gauge from a piece of wood. The piece of wood is drilled and slipped over the bit. 43

8) To clean a drilled hole, turn the bit in the drilling position as it is withdrawn from the stock. The bit should be removed frequently during the drilling process to clean the hole.

11. Selection and use of screwdrivers:

a. Description -- Standard screwdrivers are usually from 1¼ to 18 inches in length. The handles are either made of plastic or wood with a blade that extends through the entire length of the handle. Screwdriver bits for braces are about 5 inches long and their tips are ¼ to ½ inch wide. Spiral ratchet screwdrivers are available with several different types of blades.

A screwdriver should be selected according to the type of work to be performed.

A long-bladed screwdriver is easier to use than one with a short blade if enough space is available to work with it.

The standard screwdriver tip should be square and no wider than the screw head. The tip should fill the screw slot. The Phillips tip must fit the screw slot.

b. Results encountered when selecting an improper screwdriver for the job are: (Transparency I-3-S)

1) The tip will scar the wood around the head of the screw if it is too wide.

2) If the tip is curved it will mar both the screw and wood. The screwdriver cannot be kept in the screw slot.

3) Screwdrivers that are too short are difficult to use because the tip cannot be kept in the screw slot if the handle is not kept in line.

4) A small tip should never be used on a large screw; the screwdriver tip, screw slot, and the surface of the material may be damaged.

5) A tip that is too large for the screw slot will damage the screw and the surface of the material if it is forced into the screw slot.

c. Using the different types of screwdrivers: (Transparencies I-3-T and U)

1) Standard screwdrivers -- The handle is placed in the palm of one hand and the blade is guided with the other hand by holding it near the tip. The blade is kept parallel with the screw or bolt as it rotates. The hand near the tip keeps the tip square on the screw head as a new grip is placed on the head or handle.

2) Spiral-ratchet screwdrivers -- This screwdriver can be used in awkward places for driving or drawing screws. One hand is placed on the handle without releasing the grip. The other hand is placed on the chuck. The handle is pushed straight.

3) Screwdriver bit -- This bit may have a tapered or round shank. If it is used with a ratchet brace, a quarter or half turn will keep the bit from slipping in the screw slot. Pressure and balance are supplied by both hands on the brace when driving a screw into the wood. Large screws can be driven more easily with bits than with the standard screwdriver.

4) Phillips screwdrivers -- This screwdriver has a special slanted

tip that is cross-shaped
to fit into a Phillips cross-shaped screw slot. The driving method is the same as for the standard screwdriver.

5) Offset screwdrivers -- The offset screwdriver is used to drive screws in close places where other types of screwdrivers cannot be used. There is a short blade on each end, bent in the opposite direction and at right angles to the handle. One of the blades is in the same plane as the handle. Usually it is necessary to use both ends in driving a screw.

d. Misuse of the screwdriver:

1) The screwdriver is not a pry tool; therefore, it should not be used to replace such a tool.

2) Even though the screwdriver blade is bradded on top of the handle or permanently set in a sturdy handle, it should not be used as a chisel, nor should a hammer or mallet be used on it.

3) Screwdriver blades are usually either round or square. If a screw is hard to withdraw or set, pliers and wrenches should not be used on the blade to give the screwdriver extra power. The screw head may be sheared off or the tip of the screwdriver broken.

4) In some cases, screwdrivers are used as mixing tools for paints, glues, and oils. Unclean tips will slip out of the screw slots; therefore, they should not be used as mixing paddles.

12. Measuring and Marking Devices:

a. Squares

1) Framing or carpenter's square

a) Description -- This square is L-shaped with a 24 inch long and 2 inch wide body and a 16 inch long and 1½ inch wide tongue. The blade and tongue arrangement forms a right angle. On most squares the inch is divided in several graduations.

The framing square may have the following tables on the tongue and blade: brace table, for laying out common braces; the rafter table, which gives the lengths of different types of rafters; the octagon table, for making eight-sided objects; and the Essex table, for determining the board feet.

b) Use (Transparency I-3-V)

(1) Boards are squared for cutting by placing the blade firmly against the edge of the board and marking against the tongue.

(2) Another use is to lay out angles by observing a certain distance of the blade and the tongue as used for rafter cutting or making polygons and cutting at 45 degree angles. For example, using the same number on the blade and tongue (6 inch blade and 6 inch tongue), certain points on the edge of the board will give a 45 degree cut or angle. It can also be used for measuring length.

2) Try square

(a) Description -- The try square most commonly used is a 6 inch blade. The handle is not used for measuring. The blade is graduated into 1 inch, ½ inch, ¼ inch, and 1/8 inch lengths. Actually the blade length may vary from 6 to 12 inches.

(b) Use -- It is used mainly to test the squareness or accuracy of cuts. This square may also be used for short measurements and laying out lines across the face of a board from the edge. The try square is similar to the framing square in that the hand and blade form a 90 degree angle. (Transparencies I-3-W and X)

3) Combination square

(a) Description -- The combination square consists of a face and head. The head is equipped with a spirit level. The blade can be of several different lengths, but the 12-inch blade is most commonly used. The common head has a 90 and 45 degree angle to the blade. It is attached to the blade by a slot in the blade's center. The head can be moved up or down on the blade. It is graduated from 1 inch to 1/16 inch.

(b) Use -- The square can be used as a marking gauge, straight edge, try square, level, depth gauge, plumb, or mitre square. With a center head attachment, it can be used to locate the center of a round object. With a bevel-protractor head, it can mark angles in degrees. The blade can be used for measuring short lengths.

4) T-Bevel square

(a) Description -- The most common type has a 6 inch blade with a 45 degree beveled end. The blade has a long center slot which permits its movement to form a T-bevel or angles. It is usually not graduated.

(b) Use -- The main purpose of the T-bevel square is to transfer angles, bevels, and chamfers from one stock to another. It can be set on any angle by tightening the blade screw; therefore, several boards can be cut at the same angle.

b. Common types of rules: (Transparency I-3-Y)

1) Zigzag or spring-joint folding rules -- The zigzag rule is usually six feet in length. It is graduated from one inch to 1/16 inch and can be read both ways, from left to right and right to left. Some of the more expensive rules have a 6 inch extension which permits making inside measurements of objects such as door and window facings.

2) Bench rule -- The bench or one piece rule is non-folding. It is 24 inches long and 1¼ inches wide. It is graduated in sixteenths of an inch on one side and eighths of an inch on the other side.

3) Push and pull rule -- The push and pull rule is similar to a tape in that it rolls inside a round metal case. The metal rule is available in many lengths. The most commonly used length is 10 feet. It is graduated in inches. Only one side of the rule is numbered, but both edges of the numbered side are graduated in sixteenths of an inch. Some rules are graduated for the first few inches in thirty-seconds of an inch. Several types of pull-push rules are equipped with a rewind mechanism.

The push and pull rule is for measuring layout work of both short and long objects. The size of the rule permits it to be carried in the pocket. Curved or irregular surfaces may be measured by this metal rule because of its flexibility. When making inside measurements, add the 2 inch metal cast to the measurement.

4) Caliper rule -- This rule is used mainly to measure the thickness of materials by taking measurements between the jaws of the rule. Holes and width of cuts can be made by inserting the jaws and reading the inside measurement.

c. Identification and use of tapes:

1) Steel tape -- Steel tapes are found in standard lengths of 25, 50, and 100 feet. The tapes are graduated in feet, inches, and usually to one-eighths of an inch.

Tapes are used to make long measurements, and a person can use the tape effectively alone if the ring at the end or starting point is hooked in place by a nail or other holding device. The tape is used on foundations, drive layouts, and many landscaping jobs.

2) The cloth tape -- This tape is found in the same sizes and graduations as the steel tape, 25, 50, and 100 feet being the most common lengths.

The cloth tape can be used in the same manner as the steel tape. It may have a tendency to stretch, but it will not kink, which may be a common problem with the steel tape if it is not used properly. On the steel and cloth tapes with rings at the end, measurements are read from the tip of the ring.

3) Marking gauge -- The marking gauge is used to make parallel lines from either the edge, side, or end of a board. The setting of the gauge is made by the use of a rule. A reading is taken from the spur to the gauge head by a rule. It is necessary that the gauge head be pushed forward against the stock so that the spur moves at a slight angle.

C. Suggested Student Activities

1. Arrange the shop by placing a group of handtools on each shop table. Each tool should be properly marked and labeled. Allow the students time to acquaint themselves with each tool. After the students have observed and can identify each tool, remove the labels and give an exercise that allows the student to identify the unlabeled tools.

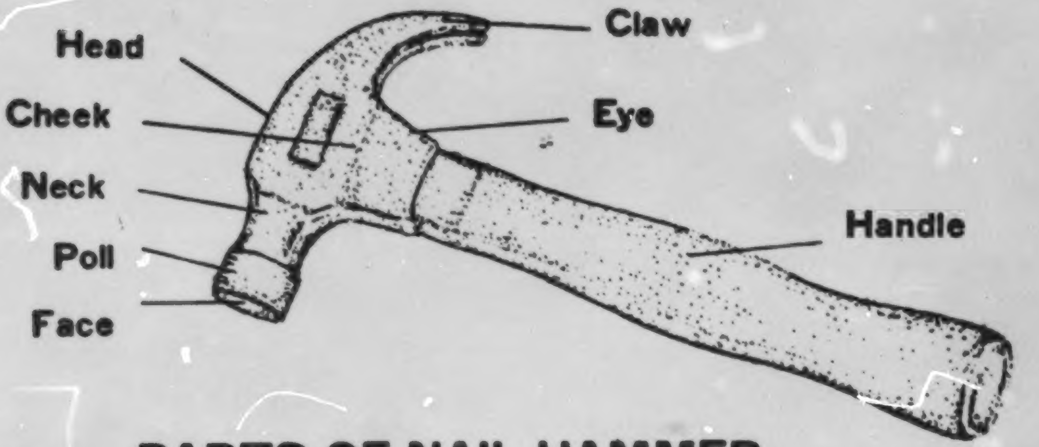
2. Design shop exercises that will give the student practice in using each major grouping of handtools. Assign groups of students to each group of tools. After each exercise, rotate the students so that each works with each major grouping of tools.

3. Assign a small shop project to be completed by each student. The project should require the use of as many different types of handtools as possible.

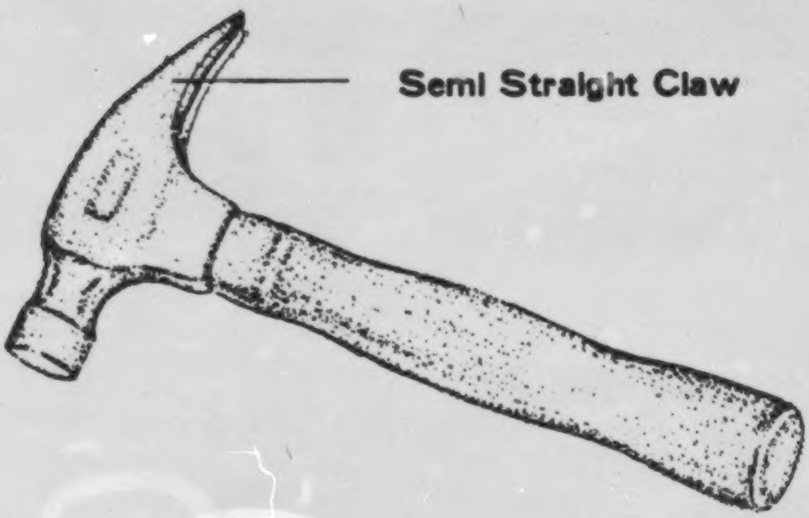
4. Assign students into groups of four. Each group will design and make a poster illustrating the safety rule and procedures for handtools.

5. Assign students oral reports to be given in class that address the care and storage of handtools.

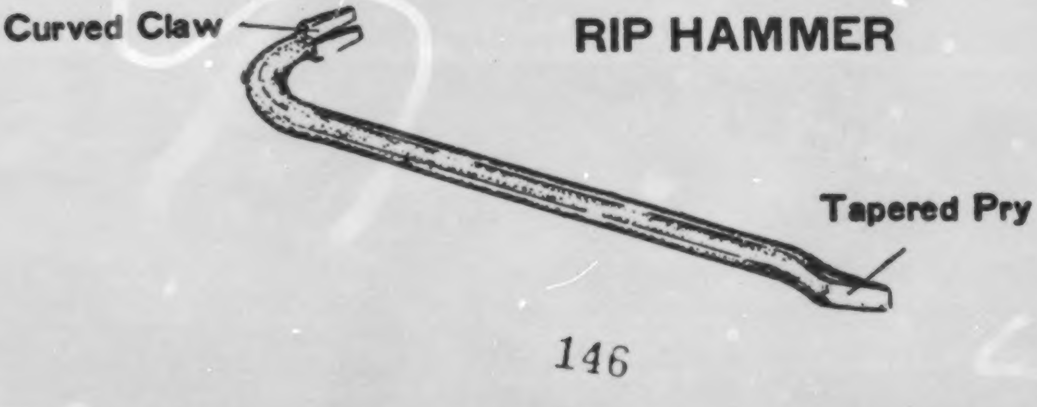
SELECTING NAIL HAMMERS


Head
Cheek
Neck
Poll
Face
Claw
Eye
Handle

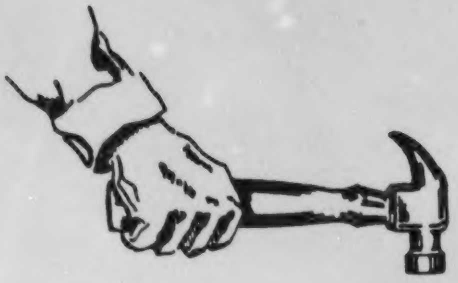
PARTS OF NAIL HAMMER


Semi Straight Claw

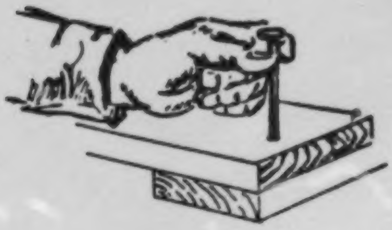
RIP HAMMER


Curved Claw
Tapered Pry

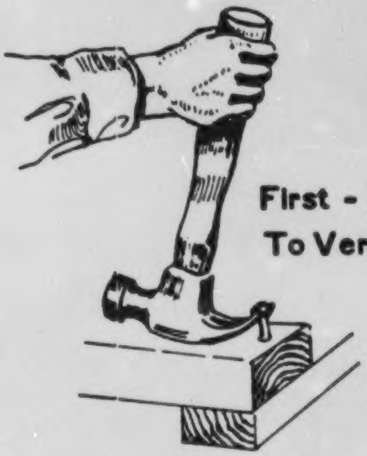
USING NAIL HAMMERS



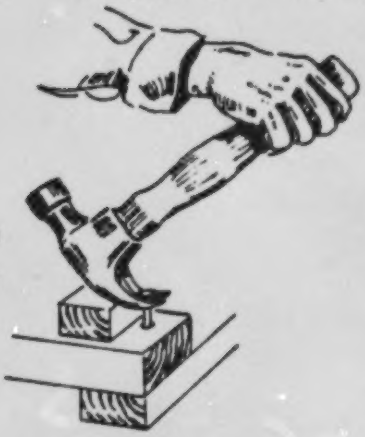
Grasp Handle Near End



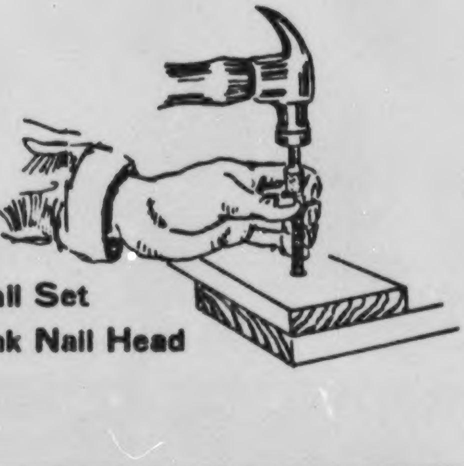
Use Finger And Thumb To Hold Nail



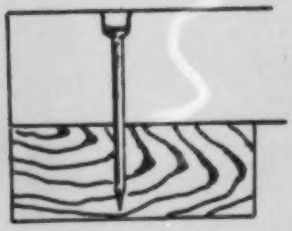
First - Raise Handle To Vertical Position



Finish Pulling Nail With Block



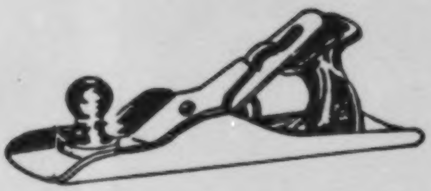
Use Nail Set To Sink Nail Head



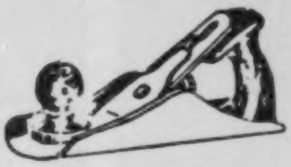
Nail Head Set 1/16 in. Below Surface

TRANSPARENCY I-3-B

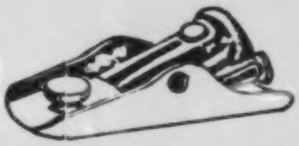
TYPES OF HAND PLANES



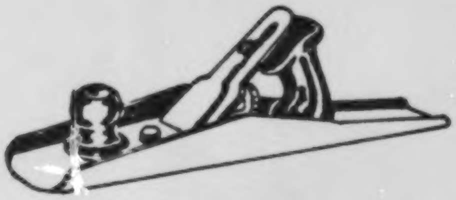
JACK



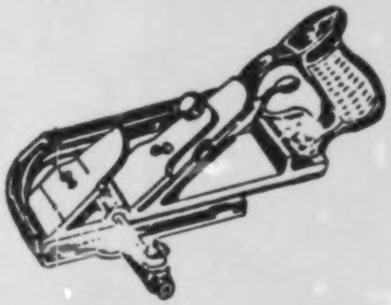
SMOOTH



BLOCK



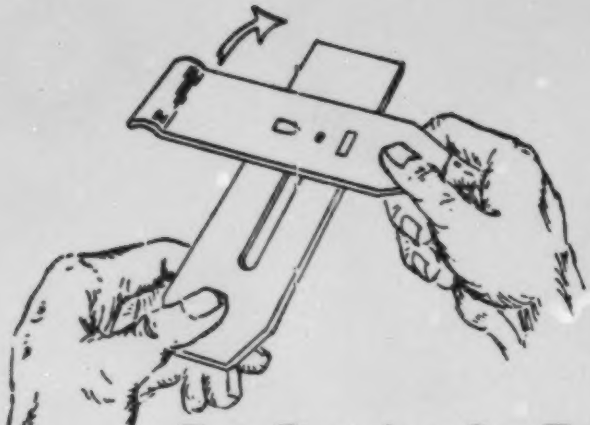
JOINTER



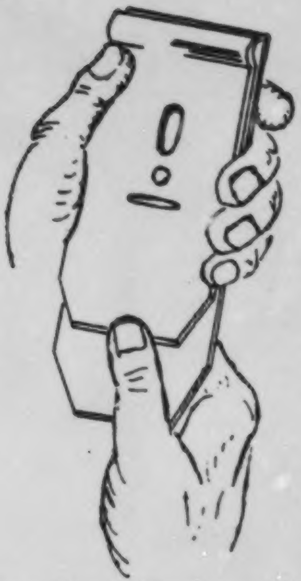
RABBET

TRANSPARENCY I-3-C

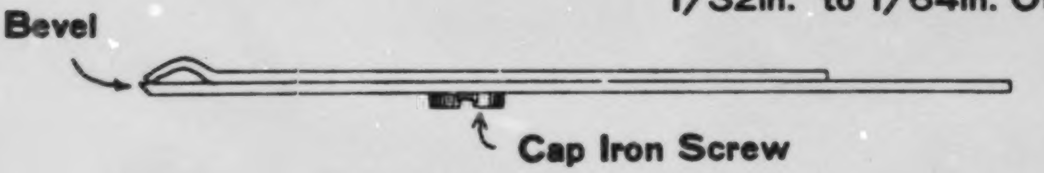
ADJUSTING IRON AND PARTS OF PLANE

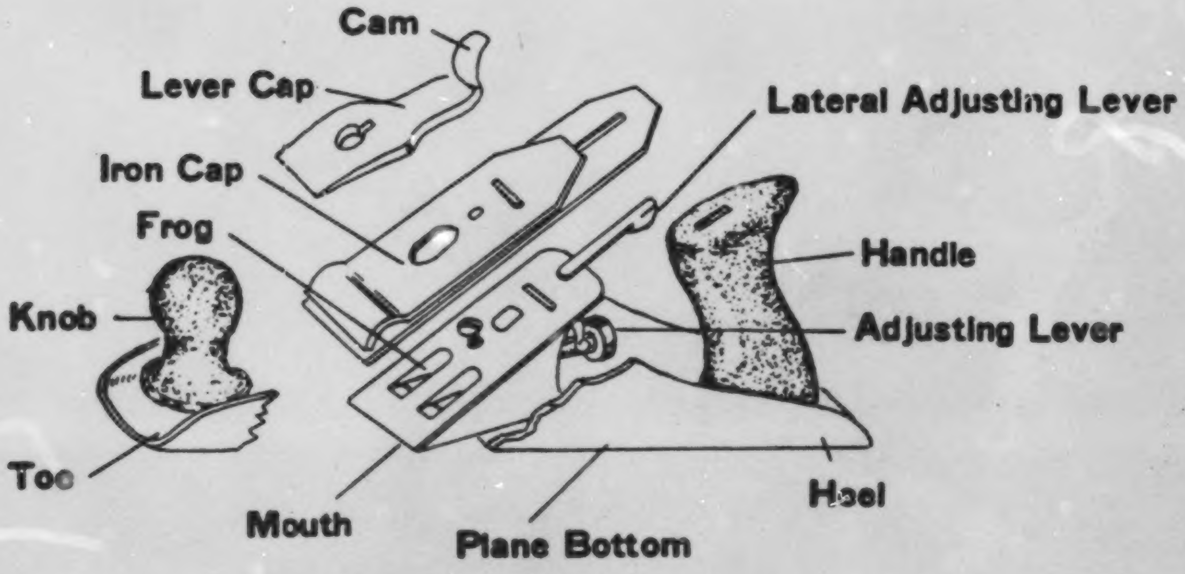


Turn Plane Iron Cap To The Right.
It Passes Back Of Cutting Edge

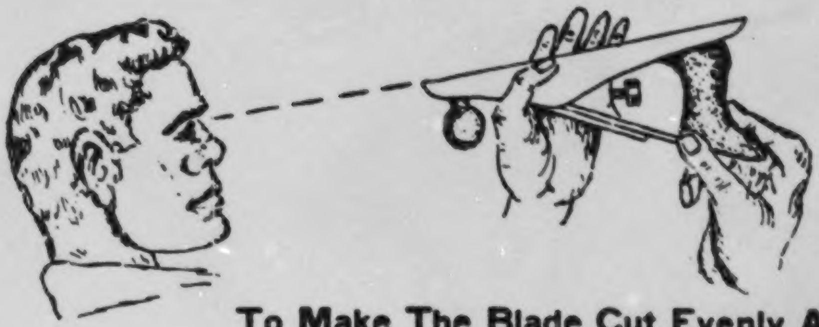


Slide Plane Iron Cap to Within
1/32in. to 1/64in. Of Blade Edg

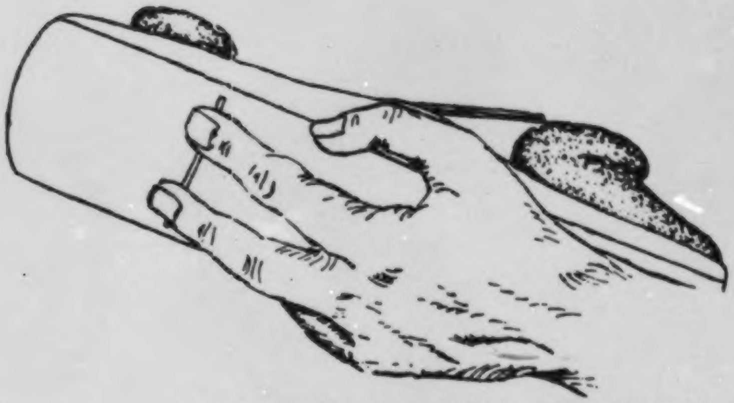

Bevel
Cap Iron Screw


Cam
Lever Cap
Lateral Adjusting Lever
Iron Cap
Frog
Handle
Knob
Adjusting Lever
Toe
Heel
Mouth
Plane Bottom

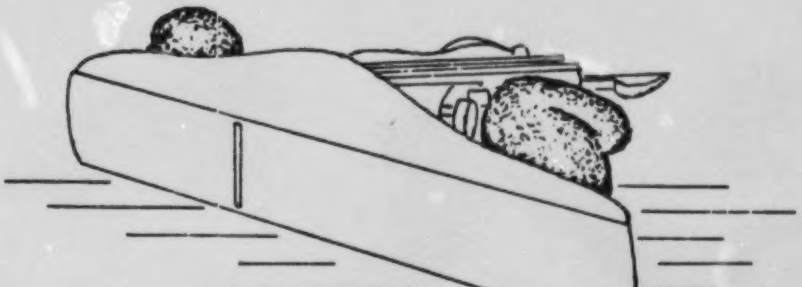
PLANE ADJUSTMENT AND CARE



To Make The Blade Cut Evenly Adjustment May Be Made By Sighting Across It



Blade Setting May Be Checked By The Feel Of Two Fingers.

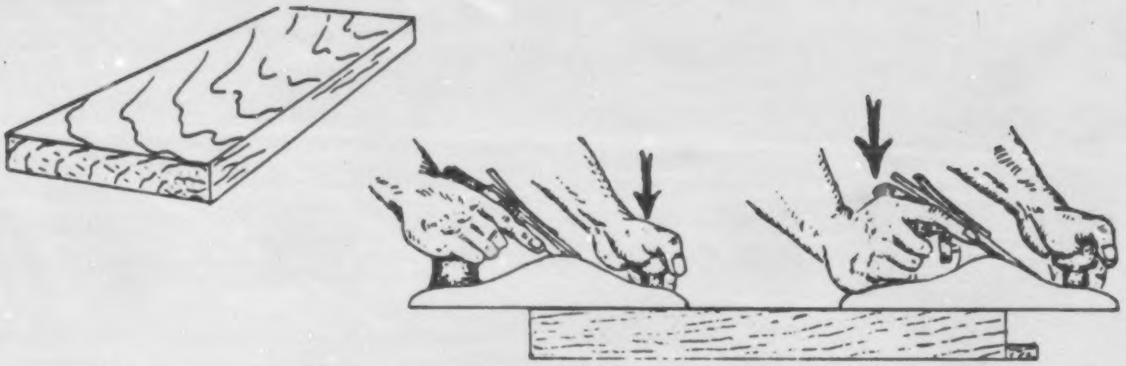


Plane Should Be Laid On Its Side To Protect The Cutting Edge.

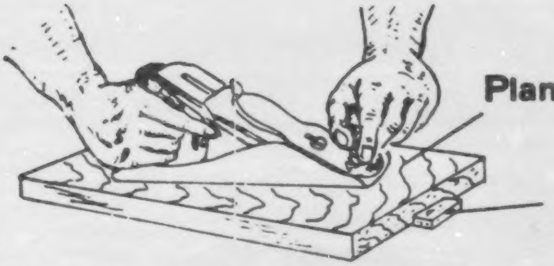
TRANSPARENCY I-3-E

USE OF THE HAND PLANE

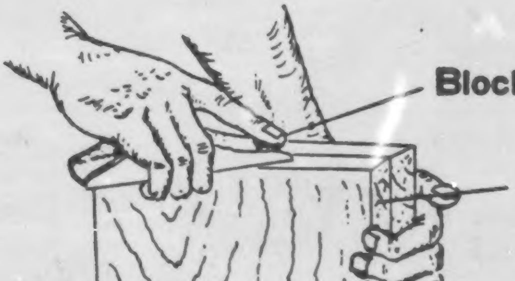
Board Or Wood Stock



Pressure Is On Knob At Start Pressure Is On Handle At Finish


Plane With The Grain
Stop Block

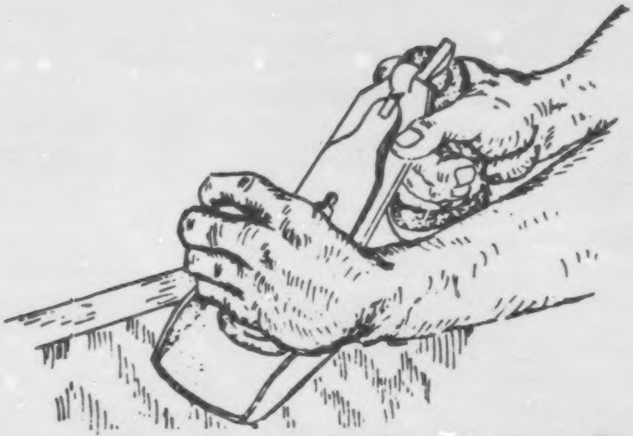
Pressure Is Equalized On Handle And Knob


Block Plane
Bevel

TRANSPARENCY I-3-F

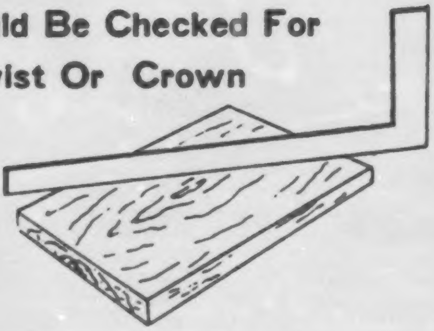
USE OF THE HAND PLANE
CHECKING PLANED WOOD STOCK

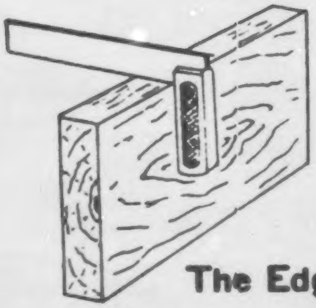
When Planing End Grain Plane To Center From Each Side.



Hold Plane At Angle When Planing End

The Surface Or Face
Should Be Checked For
Twist Or Crown

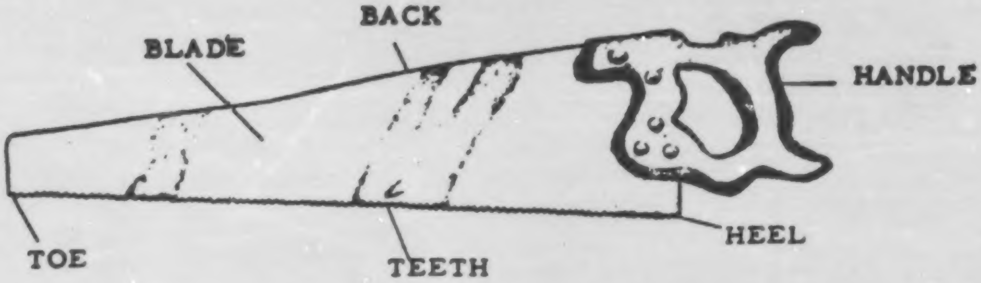


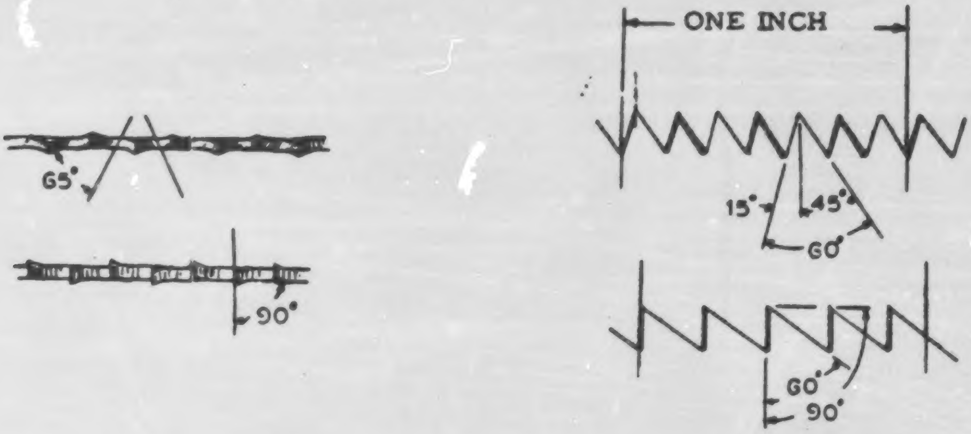


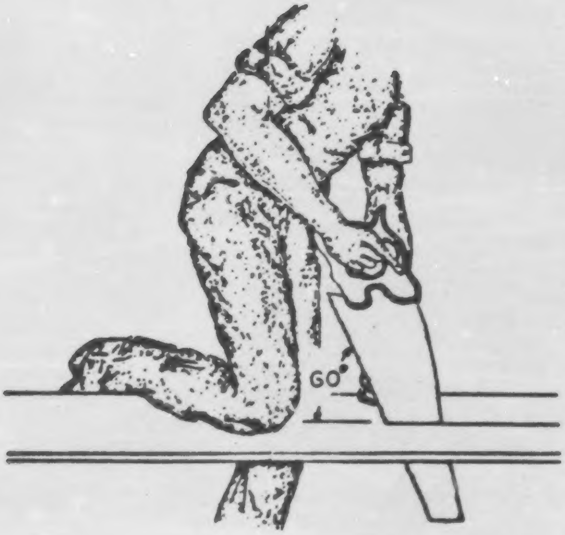
The Edge And Face Is
Checked For Squareness
While Planing

TRANSPARENCY I-3-G

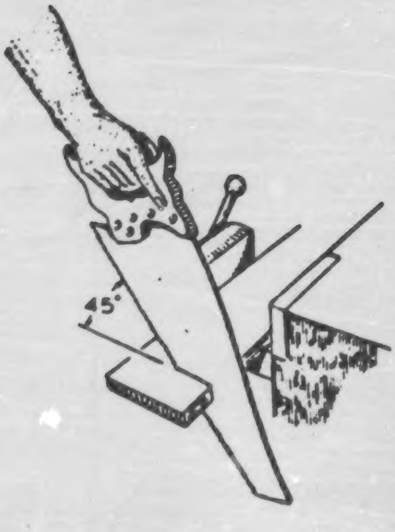
HAND SAWS


BACK
BLADE
HANDLE
TOE
TEETH
HEEL


ONE INCH
65°
15°
45°
60°
90°
60°
90°

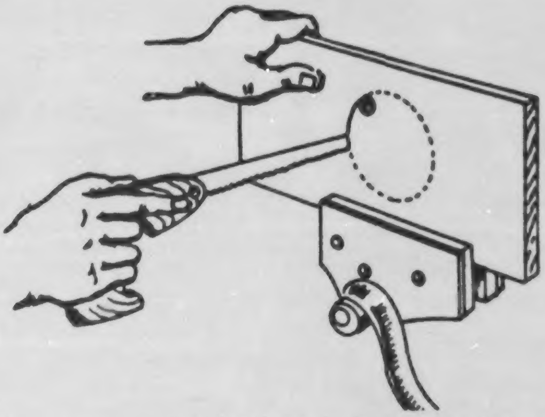


Rip saw

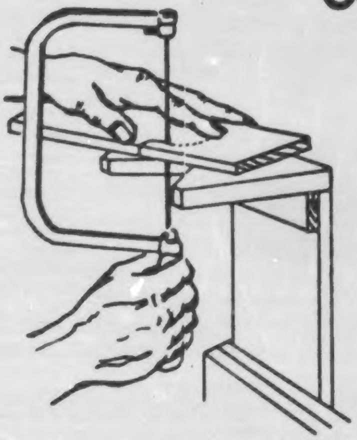


Crosscut saw

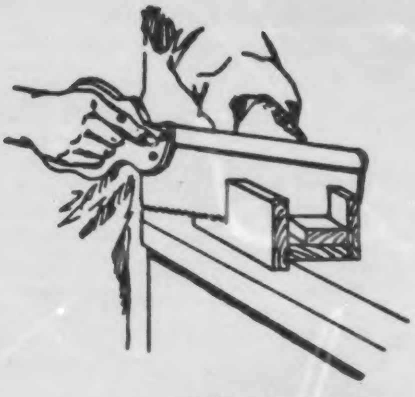
HAND SAWS



COMPASS SAW



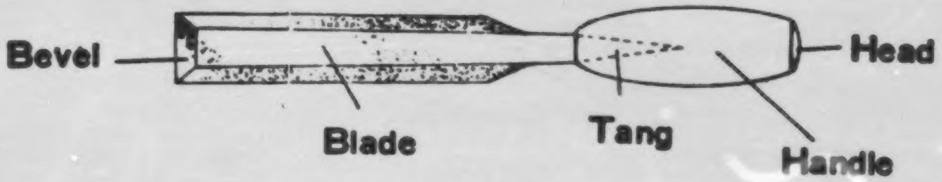
COPING SAW

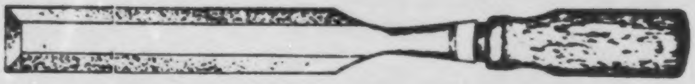


BACK SAW

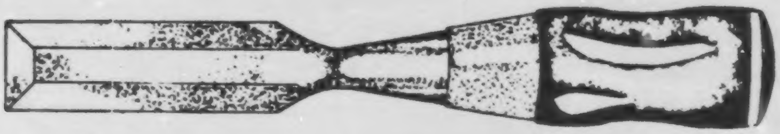
PARTS AND TYPES OF WOOD CHISELS

Parts of a Wood Chisel

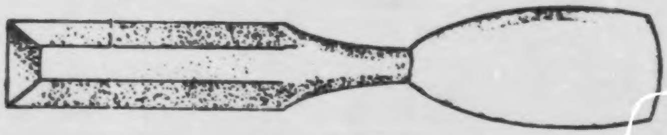

Bevel
Head
Blade
Tang
Handle



A Socket Chisel With A Wood Handle



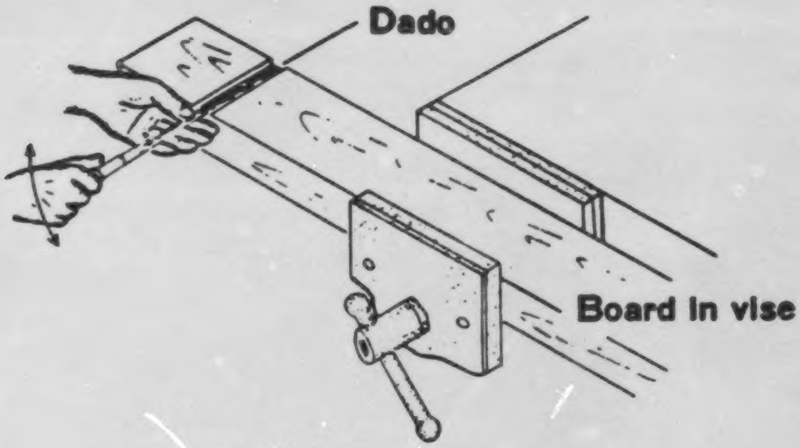
A Socket Chisel with a plastic handle

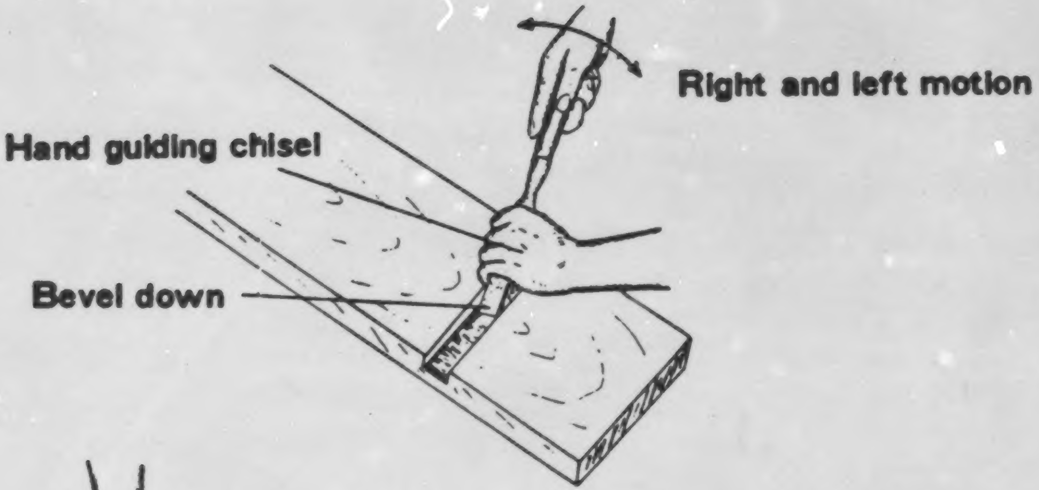


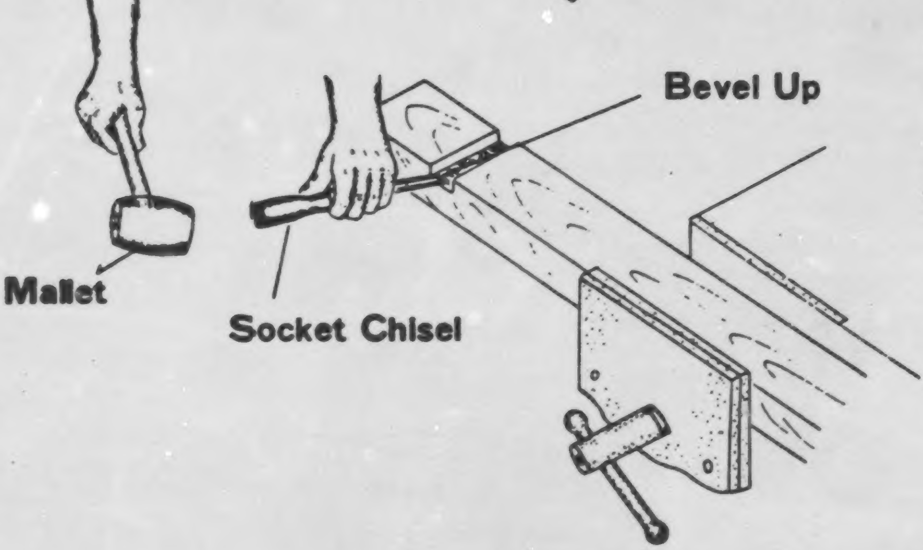
A Tang Wood Chisel

TRANSPARENCY I-3-J

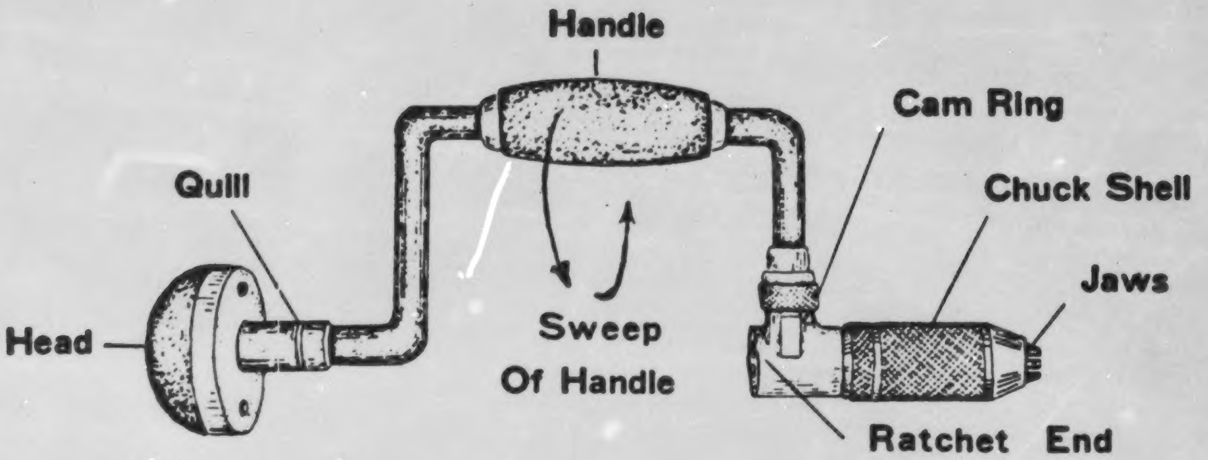
STEPS IN CUTTING WITH A CHISEL


Dado
Board in vise

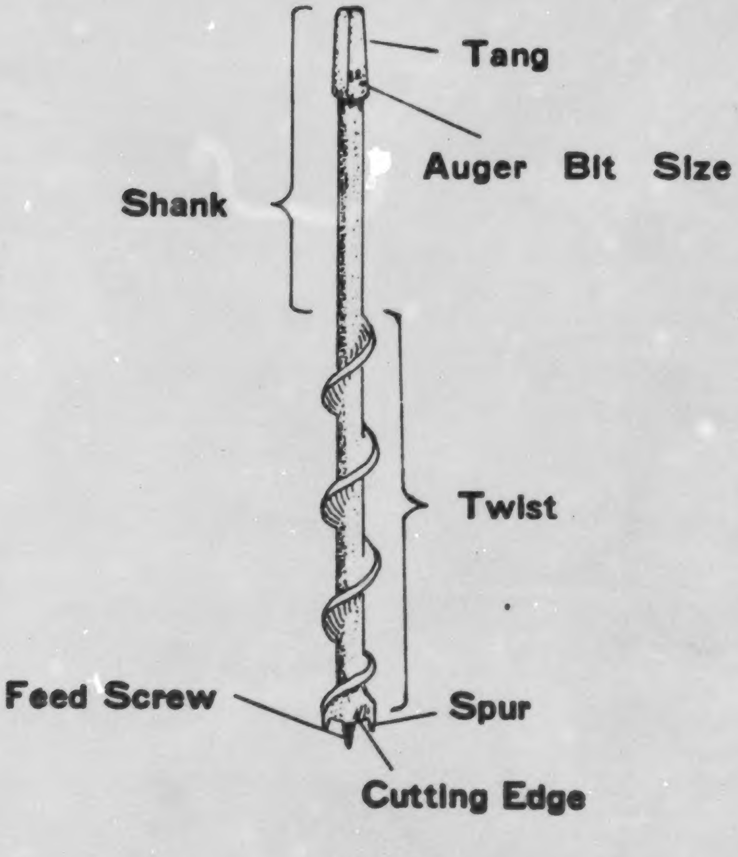

Right and left motion
Hand guiding chisel
Bevel down


Bevel Up
Mallet
Socket Chisel

PARTS OF THE BRACE

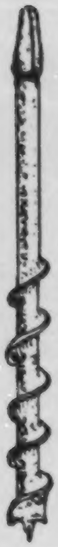

Handle
Cam Ring
Chuck Shell
Quill
Jaws
Head
Sweep
Of Handle
Ratchet End

PARTS OF THE AUGER BIT

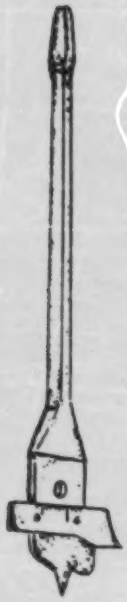

Tang
Auger Bit Size
Shank
Twist
Feed Screw
Spur
Cutting Edge

TRANSPARENCY I-3-L

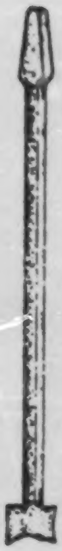
TYPES OF BITS



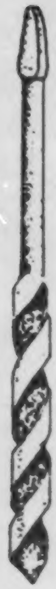
Auger



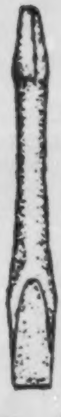
Expansive



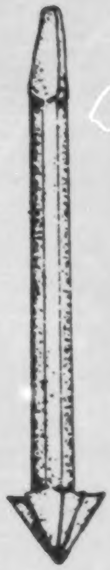
Forstner



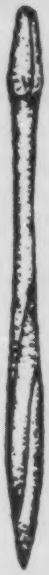
Twist



Screw Driver



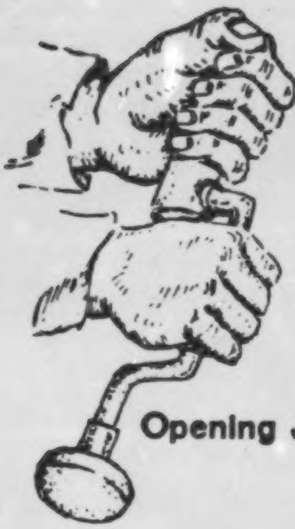
Countersink



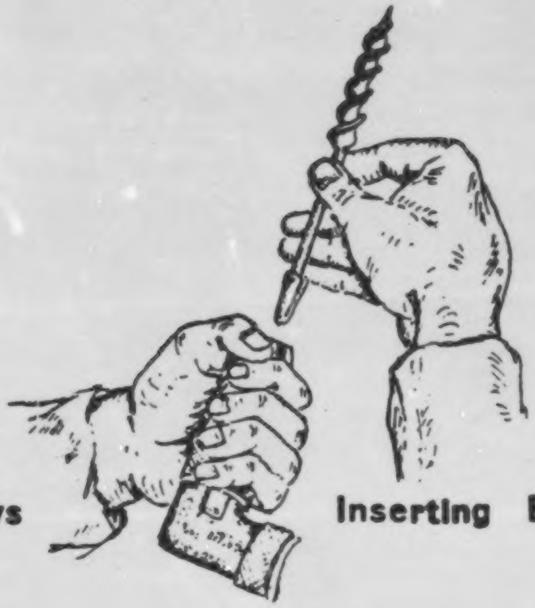
Gimlet

TRANSPARENCY I-3-11

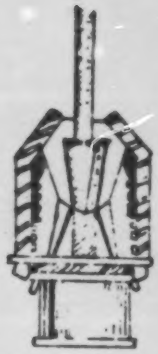
PLACING THE BIT IN THE BRACE



Opening Jaws

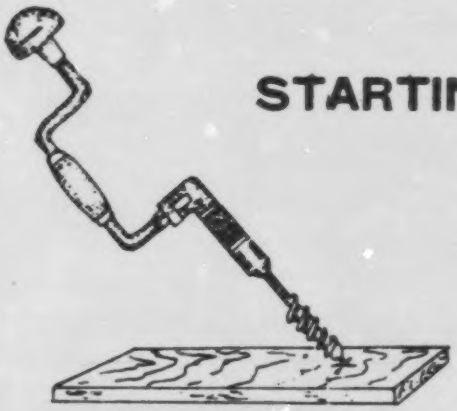


Inserting Bit

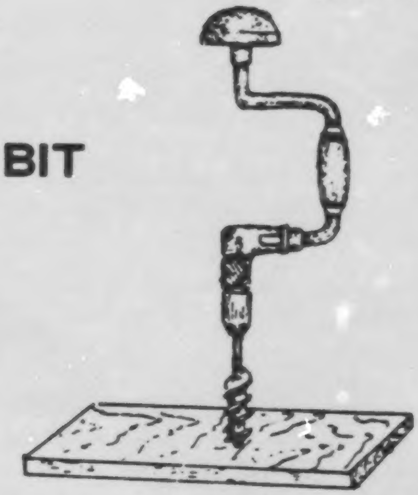


Bit Firm In Jaws

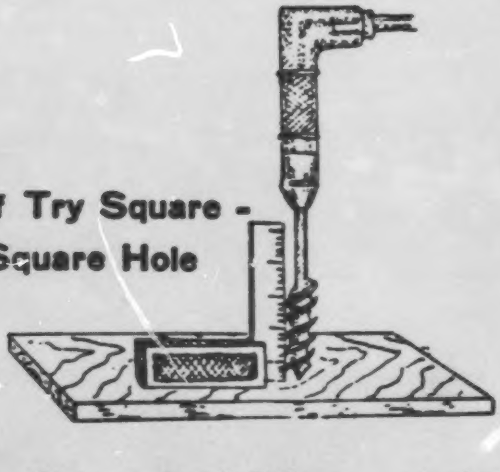
STARTING THE BIT



Point Of Bit At Cross Marks



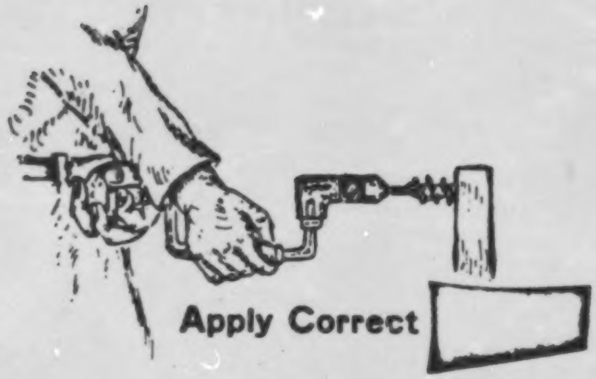
Bit At Right Angle



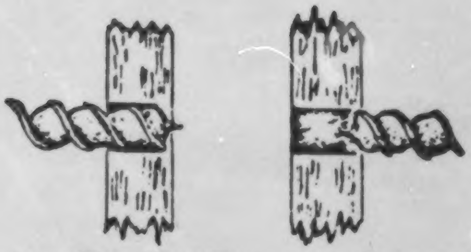
Use Of Try Square - Boring Square Hole

TRANSPARENCY I-3-N

BORING A HOLE THROUGH A BOARD

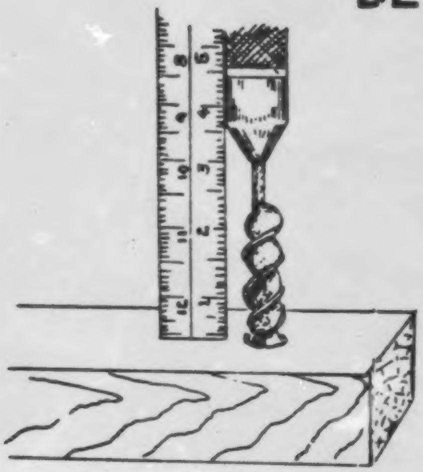


Apply Correct

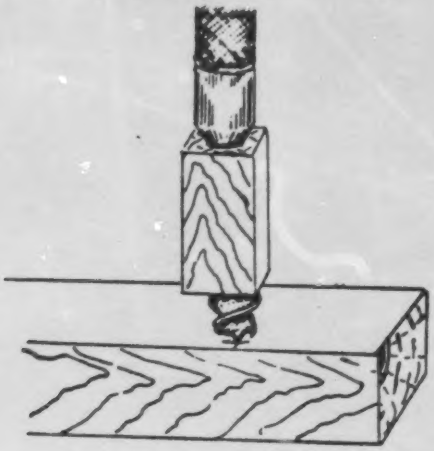


Reversing Bit To Prevent Splintering

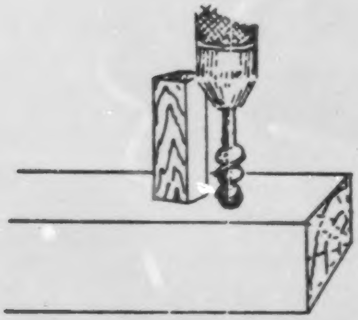
DETERMINING DESIRED DEPTH



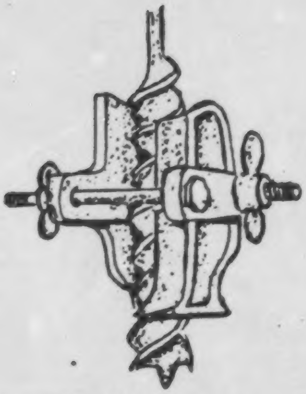
Use Of Rule For Proper Depth



Use Of Block For Depth

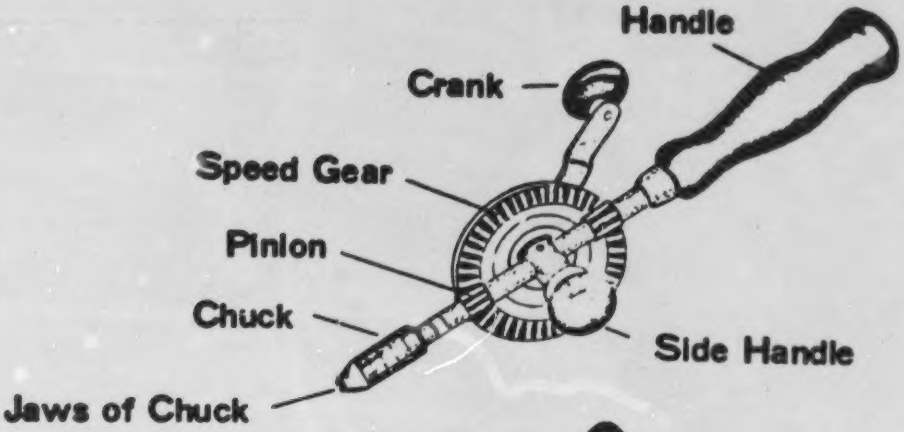


Outside Block For Depth

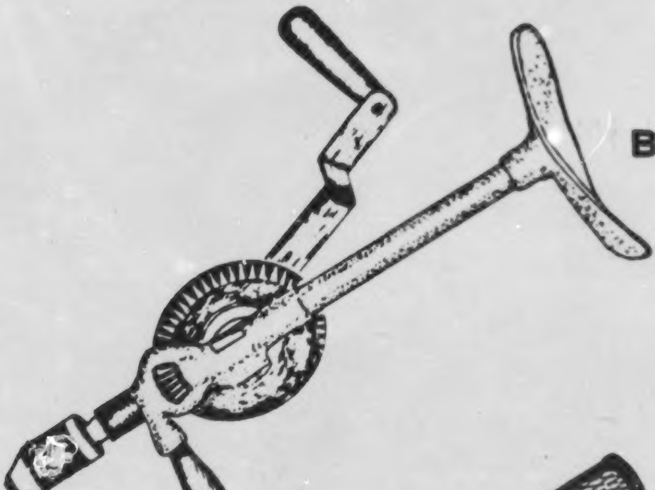


Use Of Depth Gauge

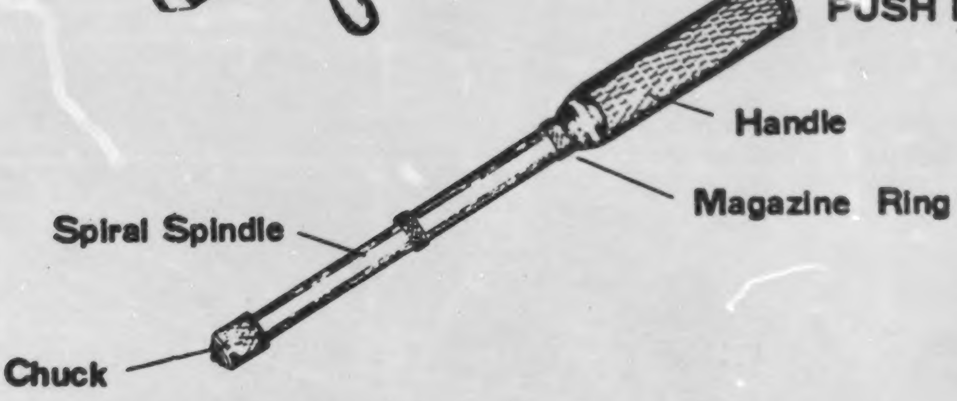
TYPES OF DRILLS AND PARTS


Handle
Crank
Speed Gear
Pinion
Chuck
Side Handle
Jaws of Chuck

HAND DRILL



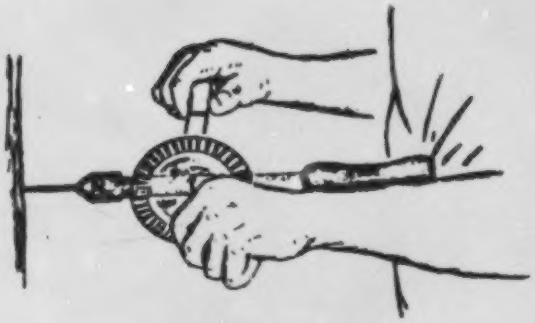
BREAST DRILL


Handle
Magazine Ring
Spiral Spindle
Chuck

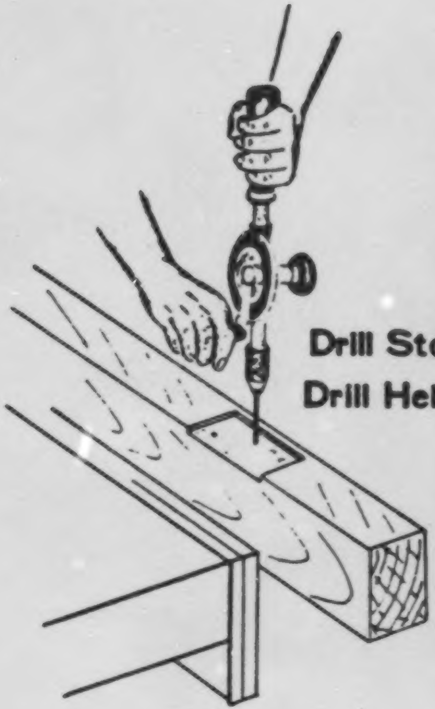
PUSH DRILL

TRANSPARENCY I-3-P

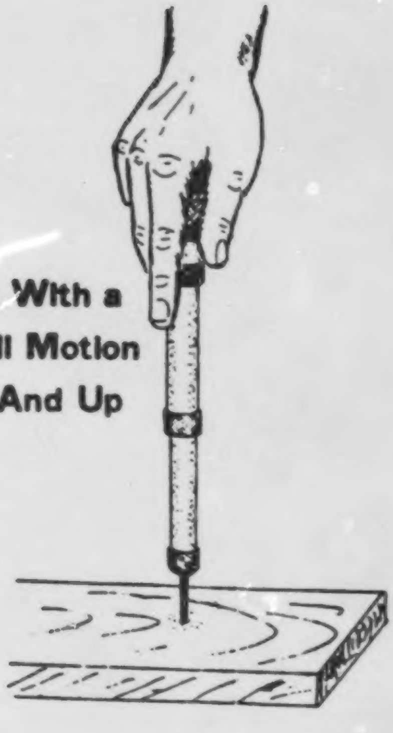
USE OF HAND DRILLS



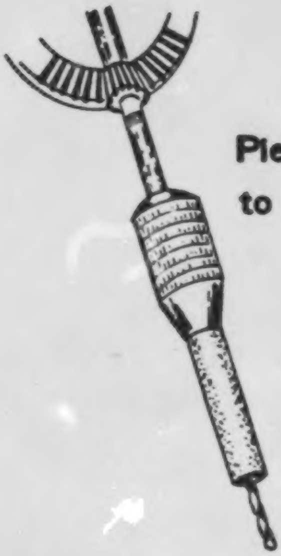
Pressure of Body Used on Hand Drill



Drill Stock And
Drill Held Firmly

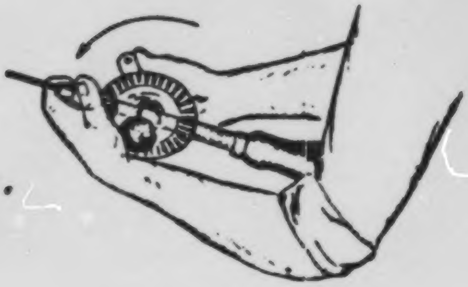


Drilling With a
Push Drill Motion
Down And Up

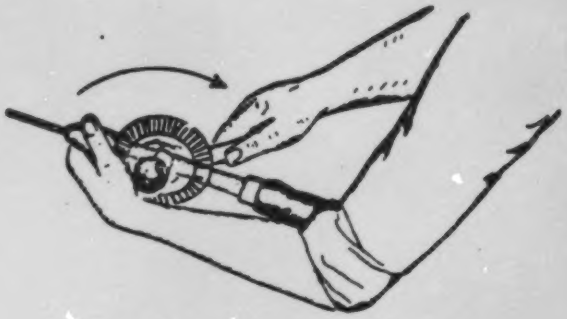


Piece of Wood Used
to Gauge Depth of Bit

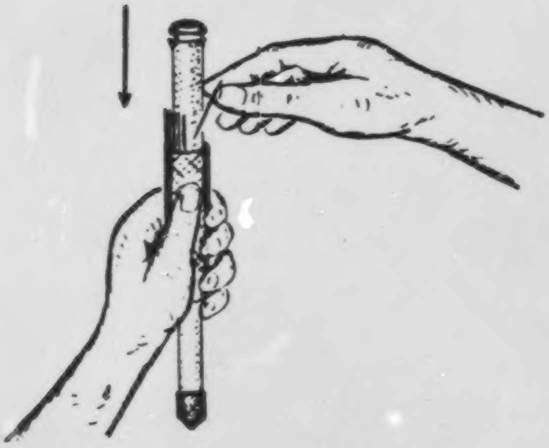
INSERTING AND REMOVING DRILL BITS



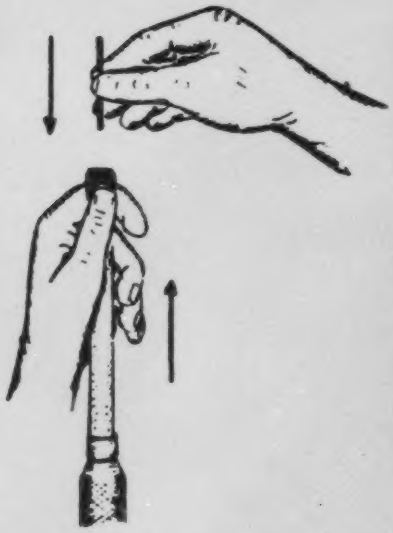
Inserting Bit



Removing Bit



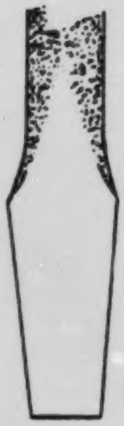
Removing Bit From Magazine



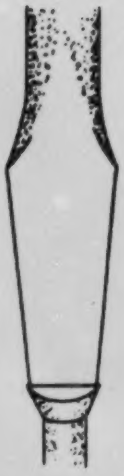
Inserting or Removing Bit

TRANSPARENCY I-3-R

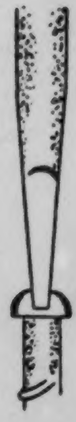
SELECTING THE SCREWDRIVER



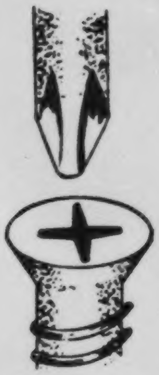
Tip Should
Be Square



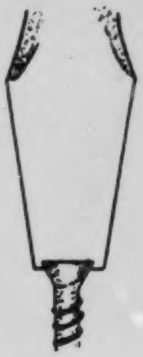
Tip Should Be
Proper Width



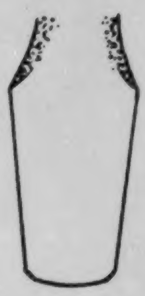
Tip Should Be
Correct Size For Screw



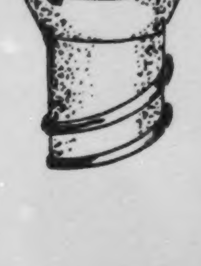
Correct Phillips Tip



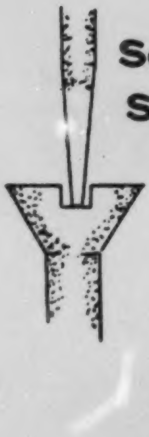
Tip Too Wide



Tip Curved

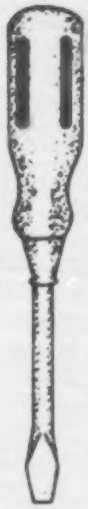


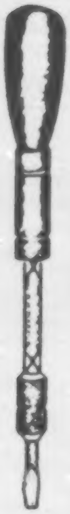
Marred
Screw Head

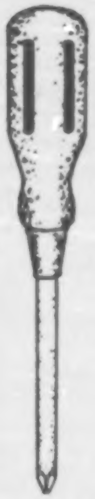


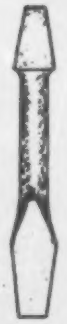
Screw Driver Too
Small For Screw

TYPES OF SCREW DRIVERS

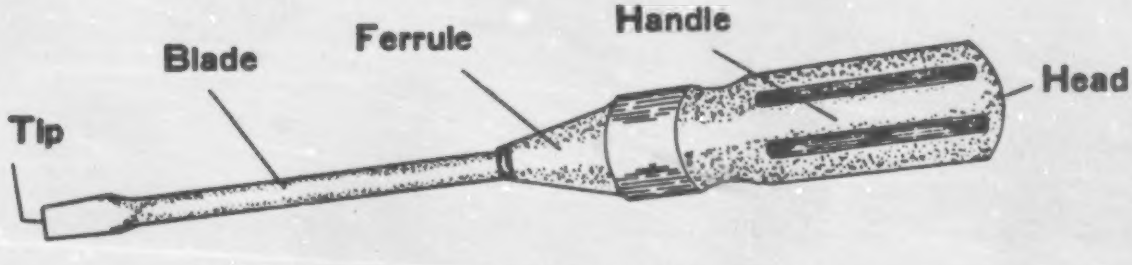

Standard


Spiral-Ratchet


Phillips


Screw Driver Bit

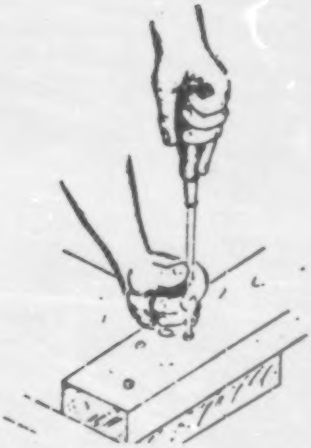
Offset


Handle
Ferrule
Blade
Head
Tip

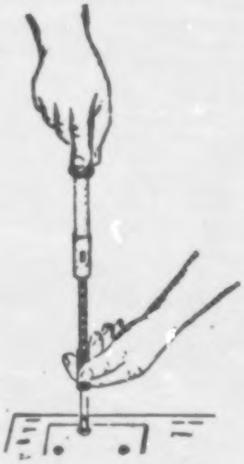
PARTS OF A SCREW DRIVER

TRANSPARENCY I-3-T

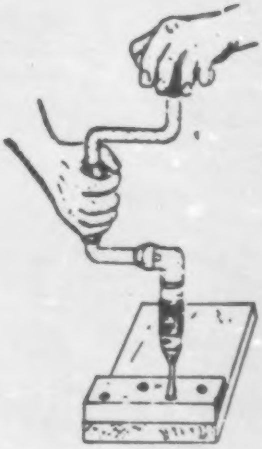
USE OF THE SCREWDRIVER



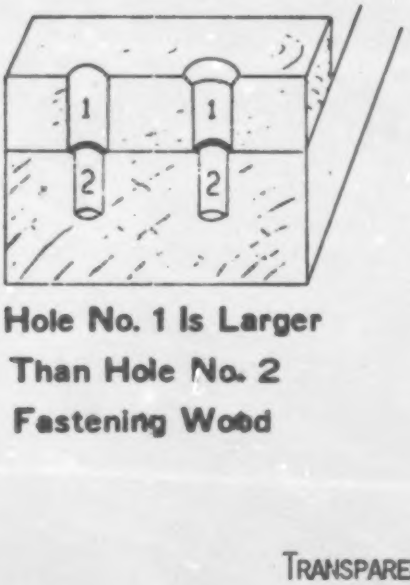
Proper Position of Hands For Standard And Phillips



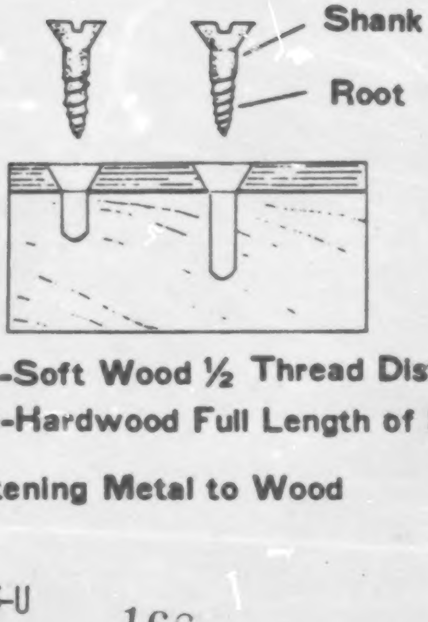
Proper Position of Hands For Ratchet



Proper Position of Hands For Use of Screw Driver Bit



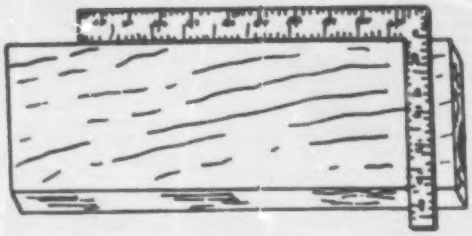
Hole No. 1 Is Larger Than Hole No. 2
Fastening Wood



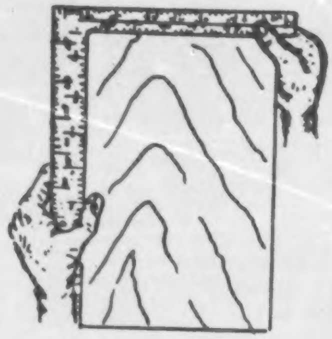
Hole-Soft Wood ½ Thread Distance
Hole-Hardwood Full Length of Screw

Fastening Metal to Wood

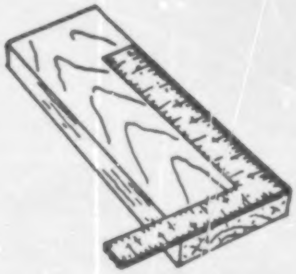
USE OF THE FRAMING SQUARE



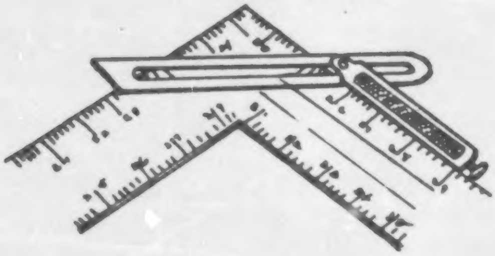
squaring board



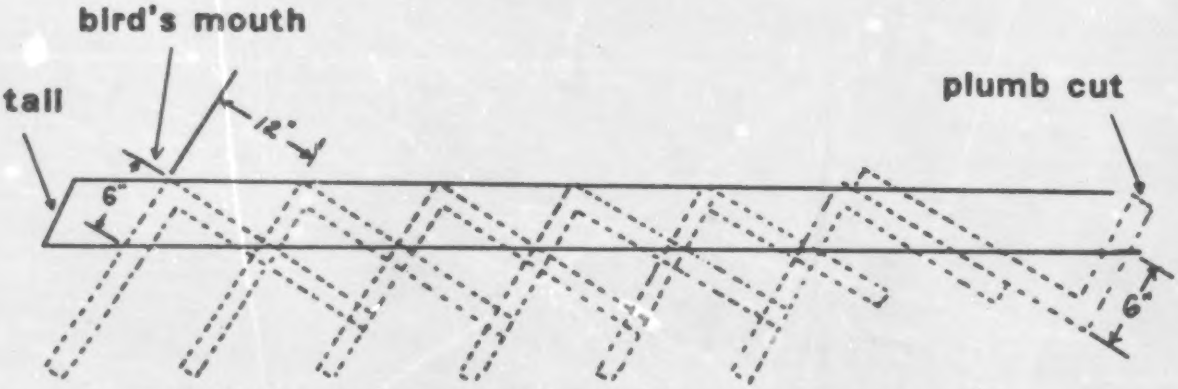
testing board



measuring board

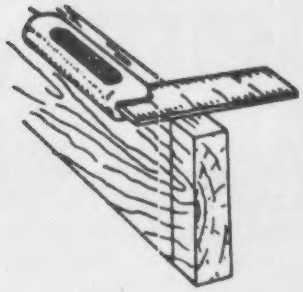


setting T- bevel

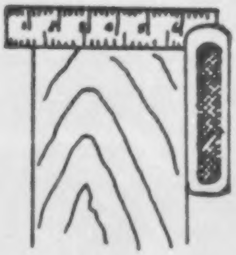

bird's mouth
tail
12"
plumb cut
6"
6"

LAYING OUT COMMON RAFTER

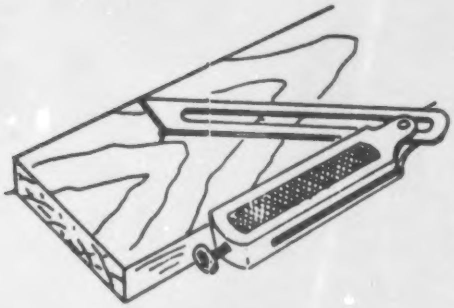
USE OF SQUARES



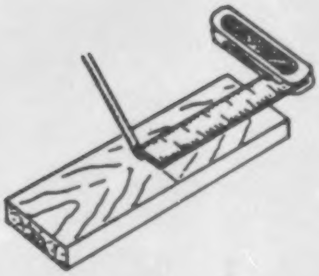
try square edge squaring



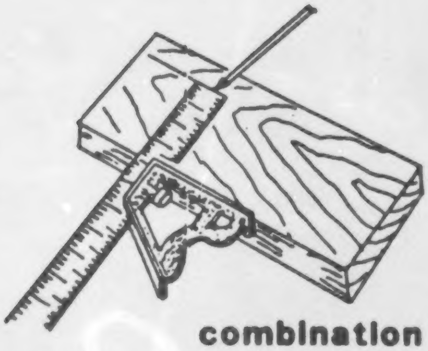
try square testing cut



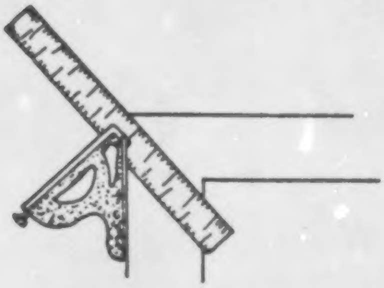
T-bevel marking angle



try square measuring

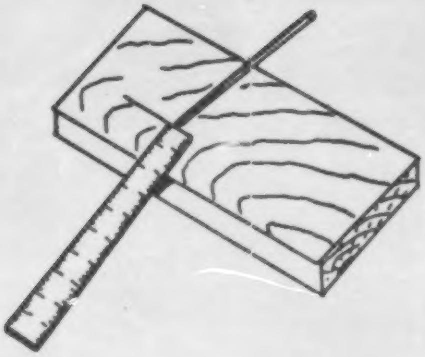


combination
marking board

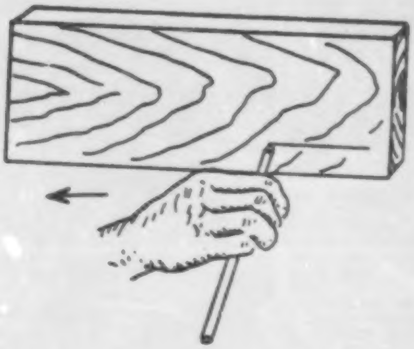


combination testing
45 degree angle

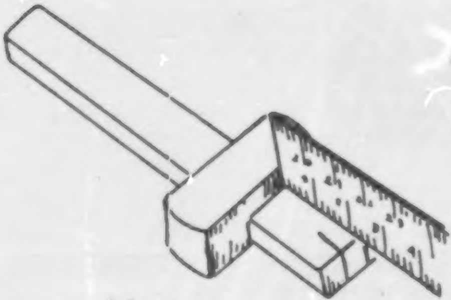
MARKING DEVICES



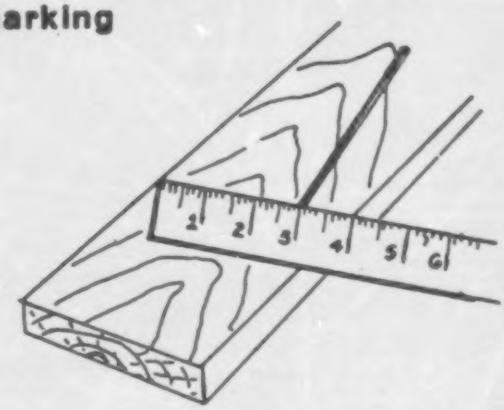
use of rule and pencil for marking



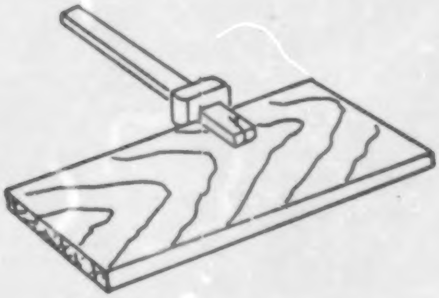
use of pencil only for marking



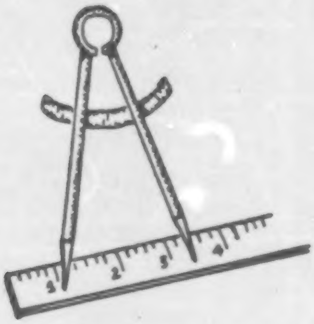
setting marking guage with rule



marking equal portion of board



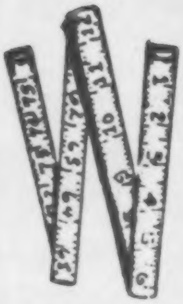
use of marking gauge



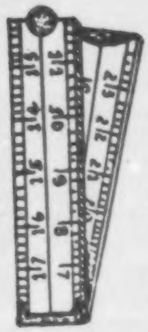
marking circles or transferring distance

TRANSPARENCY I-3-X

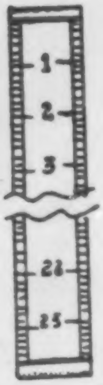
RULES, TAPE AND MARKING GAUGE



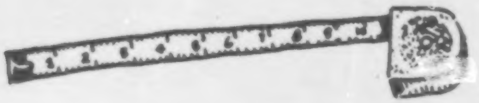
zig zag rule



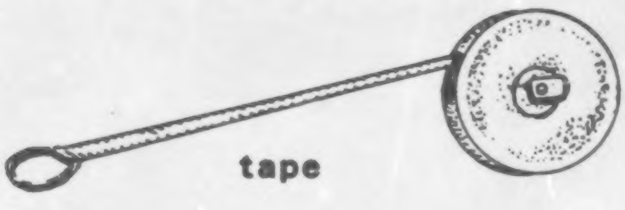
two-foot folding rule



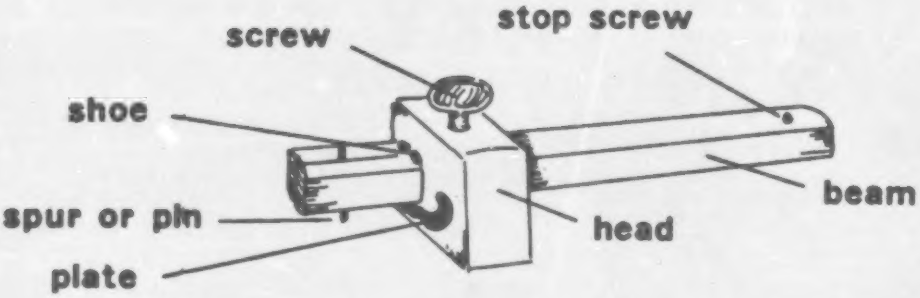
bench rule



push - pull rule



tape


screw
stop screw
shoe
spur or pin
plate
head
beam

marking gauge

TRANSPARENCY I-3-Y

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT II: Woodworking

LESSON 1: Nails, Screws, and Fasteners

I. Preparation for Instruction

A. Objectives

1. Terminal: Describe types and uses of nails, screws, and other fasteners commonly used in wood construction.

2. Specific:

a. List and describe types of screws.
b. State the characteristics used to identify screws.
c. Define the term "perry."
d. List and describe common types of nails.
e. Calculate nail length.
f. State the two main purposes for bolts.
g. List and describe common types of bolts.
h. Explain the use of corrugated fasteners and staples.
i.

j.

k.

B. Review Teaching Materials

1. Agriculture Mechanics. College Station, Texas: Texas A&M University, Vocational Instructional Services, Unit B, Topic 8, 1979.

2. Wakeman, T.J. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

1. Materials

a. Exhibits of wood screws, nails, bolts, and other fasteners as outlined in the lesson.

b. Various types of nail and screw charts depicting the different types of nails and screws and some of their common uses.

2. Audiovisual

Overhead projector/transparencies

II. Presentation of Lesson and Suggested Study Activities

A. Motivation

1. It is important to determine what fasteners and other hardware are needed, such as nails, screws, and corrugated fasteners and how these fasteners are properly utilized.

2. The shop project will require familiarization with all of the different fasteners that are available for wood construction.

3. There are many different kinds and uses of nails. The right nail for the right job will ensure correct assembly and result in an overall more professional finish.

B. Content Outline

1. Types of screws used on woodwork

   a. Flathead screws -- These screws are the most popular for attaching or fastening pieces of wood together. They are used where the head is to be covered by a wood plug or dowel.

   b. Round head screws -- Round head screws are used to give the finished article an ornamental effect; and when washers are used, extra holding support is furnished for the object.

   c. Oval head screws -- These screws are used where it is not necessary to have the screw head flush with the surface. They also give the article an ornamental appearance.

   d. Lag or coach screws -- The big screws resemble a bolt except at the screw root. They usually have a square head and are used where the regular screw is not strong enough for the work. Leg screws are also used with an expansion shield in brick, concrete, and rock walls.

   e. Drive screw -- The drive screw head is similar to the flat head screw without the slot. The screw actually turns as it is being driven into the wood. It has an auger type of root instead of a threaded root.

   f. Phillips screw -- The only difference between the flathead and Phillips screw is the straight single slot in the flathead screw and the cross-shaped slot in the Phillips screw. The two types of screws can be used for the same purposes. The recessed Phillips screw requires a special screwdriver. It is considered to have a greater drawing power than the regular head screw. (Transparency II-1-A)

2. Metals and finish of wood screws

   a. Screws are made of steel, brass, alloy, bronze, and copper metals.

1) Steel screws are used for ordinary work, and they are cheaper than bronze and copper screws.

2) Brass and alloy types of screws are best suited for construction purposes where the screw is subjected to moisture.

3) Copper screws are used mainly with copper metals, giving the finished product an ornamental appearance.

b. Screws are finished in many colors -- bright metal, blue, brass, bronze, and copper. Some screws are painted in various colors.

c. Screws are identified according to length, gauge, finish, and head. For example: a 1¼ inch number 10, flathead steel screw is written 1¼" - No. 10 F. H. S., and the same screw in brass, but round head is written 1¼" - No. 10 R. H. B. The gauge number of screws range from 0 to 24 and the length from ¼ to 5 inches.

3. Identification and use of nails

The nail is one of the most commonly used kinds of rough hardware. Nailing was one of the first ways used to join pieces of wood together. The early nails had four flat sides instead of being round. They resembled our present day horseshoe nail.

The term "penny," indicating the common nail size (length), came from one of the following sources of measurement in England.

a. Six-penny and ten-penny nails could be purchased for either a six pence or tenpence per 100 nails.

b. One thousand nails of a certain size (six-penny) weighed six pounds.

The letter "d" is used as a symbol for penny.

4. Types of nails most commonly used are: common, box finishing, roofing, flooring,

plasterboard, casing, and shingle. The two general types of nails are wire cut or cut nails. (Transparency II-1-A)

a. Common nails -- These nails are used more frequently than any other type of nail. They have flat heads and range in size from 2d to 60d. The larger common nails are known as spikes. They are used for round work where holding power is important. They are used mainly on rough work such as framing, fencing, and farm building.

b. Box nails -- Box nails range in size from 2d to about 40d. They have less tendency to split the lumber than does the common nail because they are smaller in diameter. Box nails are used for building crates, boxes, and the nailing of siding. They are also made of wire and have flat heads.

c. Roofing nails -- Roofing nails have a very large flat head. The shanks are of different sizes and types. The most common shank is barbed. The nails are used to install rolled or shingle asphalt roofing. They range in size from about 3/4 to 2 inches. These nails are galvanized.

d. Finishing nails -- These nails are used for finish work. The heads are small and barrel shaped so they can be sunk below the surface and the holes filled with a wood filler or putty. The sizes range from 2d to 20d. These nails are used on cabinet trimmings and cupboards.

e. Flooring nails -- As the name indicates, these nails are used mainly for nailing flooring; but they are used on other heavy materials. The nail diameter and head is slightly larger than the finishing nail; however, the head can be countersunk. The flooring nail ranges in size from about 7d to 10d.

f. Plasterboard or gypsum board nails -- These nails are small with a flat head. They range in size from 1 to 1¼ inches in length. They are used to join plasterboard to a wood base. These nails are also used to apply rock lath (a base for plastering).

g. Casing nails -- These nails can be used for flooring, but they have a smaller head and smaller shank in diameter than does the flooring nail. The head can be countersunk. These nails range in size from 4d to 40d and are used mainly for outside finish work. They are thicker than a finishing nail.

h. Shingle nails -- Nails of this type are small (3d to 6d) with flat heads used primarily with asphalt shingles. The galvanized box nail is used for wood shingles.

i. Hinge nails -- Hinge nails are used for lattice work and roofing because of its holding power. They have oval or countersunk flat heads and range in size from 4d to 20d.

j. Other types of nails -- Other types of nails are: masonry, duplex-headed, ratchet, T, copper clout, lead-capped metal roofing, and screw and plain shank roofing.

5. Nail length can be determined in the following manner: A 2d nail is 1 inch in length and each size thereafter increases ¼ inch in length through the 16d nail. For example: A 6d nail is 2 inches and a 7d nail is 2¼ inches in length. The gauge also becomes larger if the length increases more than two sizes between 4d and 12d nails.

6. Identification and use of bolts.

   a. There are two main purposes for using bolts and fasteners.

      1) Bolts are considered the strongest of all fasteners for wood. They are used where a strain is put on pieces of boards that are jointed together.

      2) Bolts are used in heavy construction where it is necessary to

assemble and disassemble objects.

b. Types of bolts most commonly used are: carriage bolts, stove bolts, machine bolts, toggle bolts, and lag bolts with shields. (Transparency II-1-B)

1) Carriage bolts are generally considered the woodwork bolt because of the square shank under the round oval head. The square shank prevents the bolt from turning once it is set in the wood. The head cannot be held by a wrench; therefore, it may be difficult to remove, especially if the bolt is covered with rust. The length may range from about 1 inch to 20 inches. These bolts are threaded like machine bolts.

2) Stove bolts are used for lighter work than are carriage bolts. They have round and flat slotted heads and may be loosened or tightened with a screwdriver. The stove bolt may be purchased with a Phillips head and in many sizes. The threads extend the full length of the bolt. The length of stove bolts ranges from 3/8 inch to 6 inches.

3) Machine bolts may be used for heavy wood construction such as livestock feeders, gates, and trusses for buildings. The head of a machine bolt can be held with a wrench while it is being tightened. The size range is similar to a carriage bolt, about ½ to 1¼ inches in diameter, and the length is from 1 to 30 inches. These bolts are used for heavy construction.

4) Toggle bolts are supplied with a spreading head nut that opens as it passes through the wall; therefore, its main purpose is to fasten objects by drilling a hole and inserting the spreading nut through the hole. It is tightened with a screwdriver. The bolt is designed

to join small objects to walls and other objects.

5) Lag bolts are used with expansion shields to fasten wood and other materials to concrete, bricks, and stone. When a lag screw or bolt is inserted into a metal shield, the shield expands in the hole as the square head of the bolt is turned clockwise with a wrench. This bolt does not have a nut. When attaching metal to wood or wood to wood it is necessary to drill holes of two sizes -- one for the threaded part and one for the nonthreaded part.

6) Anchor bolts are used to fasten sills and plate to concrete foundations and walls. They can be made in various lengths. Usually only one end of this bolt is threaded.

7. Use of corrugated fasteners and staples

a. Corrugated fasteners are used to join boards together such as corners and butt joints in windows and doors and corners for picture frames. The thickness of the corrugated fastener should be at least 1/8 inch less than the thickness of the board on which it is used. The fasteners range in size from 1 to about 6 inches in width and from ¼ to 1 inch in depth. Regardless of the width of the fastener, it should be driven evenly into the material.

b. Staples range in sizes from 3/8 inch to 2 inches. Wide crown staples have a 1 inch crown. They are used with a staple gun. Staples are used for millwork, asphalt shingles, butt joining, and ceiling materials. Wire staples are made in different sizes. The staple used to construct barbed wire and heavy net wire fences may be about 1 inch long, while the small mesh wire staple may be less than 3/4 inch in length. Fencing staples vary in length from about 3/4 inch to 2 inches.

C. Suggested Student Activities

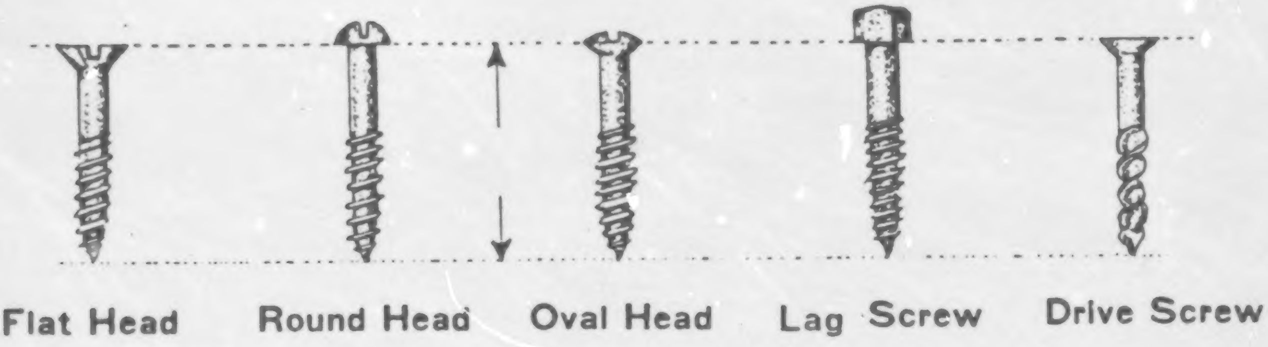
1. Each student will be asked to identify various types of screws, nails, and bolts according to the characteristics discussed in class.

2. Each student will make out a bill of materials required to assemble a shop project. The project should include various screws, nails, and bolts. Each student should specify the type(s) of nails, screws, and bolts that will be used.

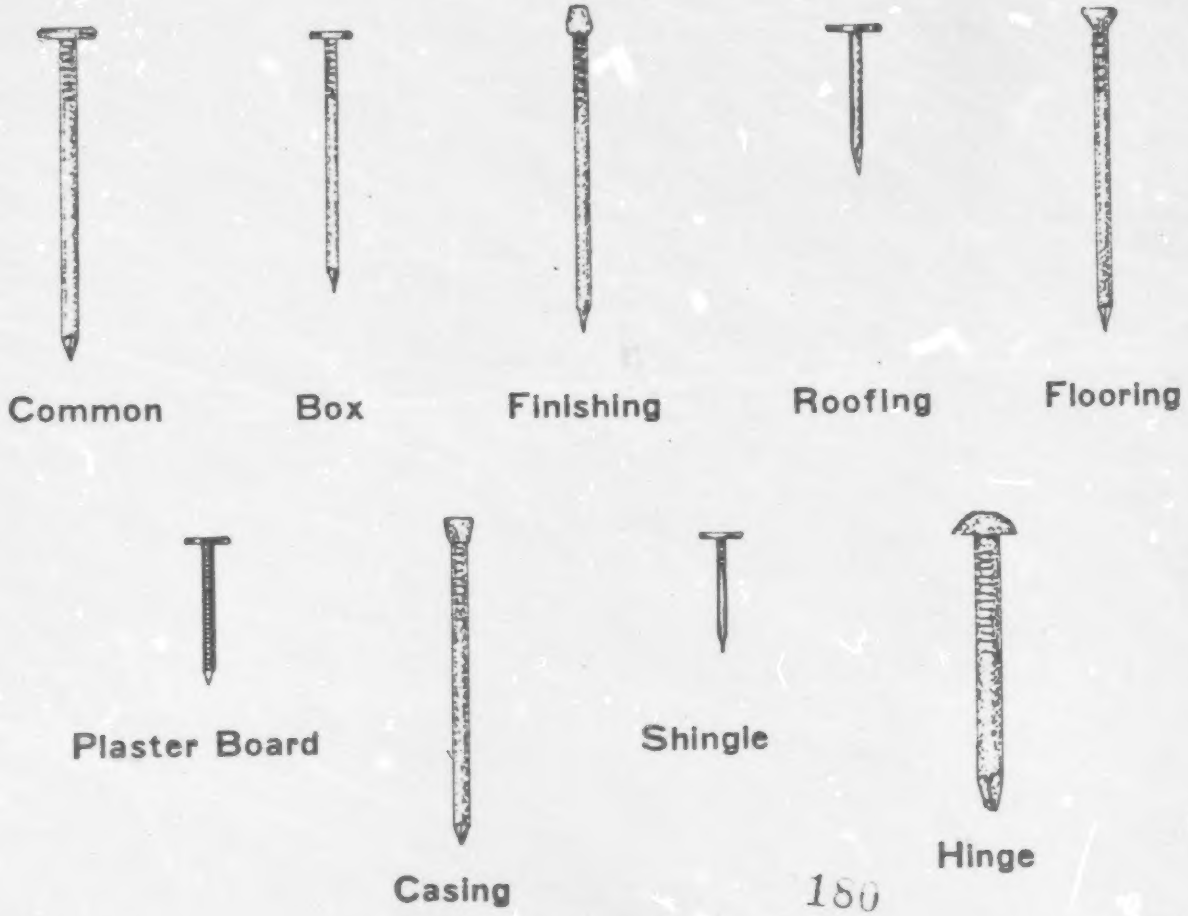
3. Class will discuss the use of corrugated fasteners and staples by giving examples of how they are used.

4. Each student should visit the local hardware store or lumber yard to make a list of how screws, nails, bolts, corrugated fasteners, and staples are categorized and sold.

TYPES OF WOOD SCREWS

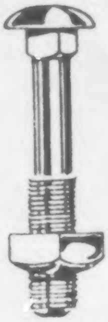

Flat Head
Round Head
Oval Head
Lag Screw
Drive Screw

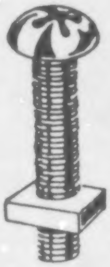
TYPES OF NAILS

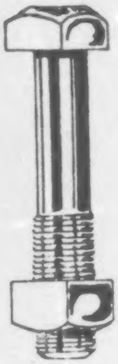

Common
Box
Finishing
Roofing
Flooring
Plaster Board
Shingle
Hinge
Casing

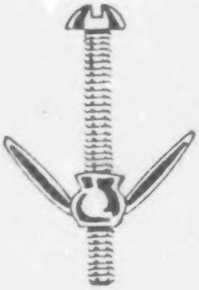
TRANSPARENCY II-1-A

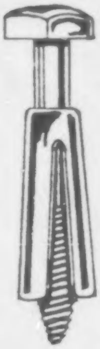
TYPES OF BOLTS AND OTHER FASTENERS

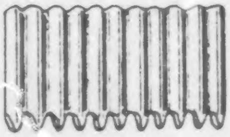

Carriage

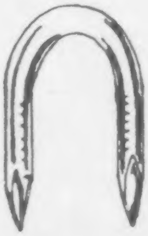

Stove

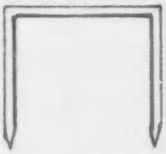

Machine

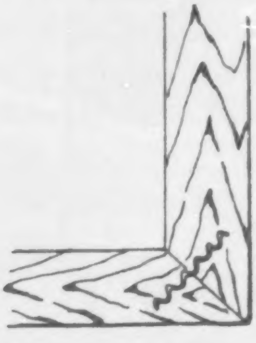

Toggle


Expansion


Corrugated fastener


Wire staple


Standard staple


Use of corrugated fastener

TRANSPARENCY II-1-B

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT II: Woodworking

LESSON 2: Basic Mathematics in Carpentry

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Describe the use of basic math skills in woodworking.

2. Specific:

   a. Explain the importance of learning basic math skills in carpentry.
   b. Describe the divisions of a ruler or tape.
   c. Calculate square feet.
   d. Explain the importance of understanding angles in project construction.
   e. Describe two methods of determining lumber dimension.
   f. Explain the need for knowing units of measure for various building materials.
   g.
   h.
   i.

B. Review of Teaching Materials

1. Phipps, L.S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

2. McCoy, V.L. and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

1. Secure rulers, folding rulers, or tape measures for each student.

2. Obtain rough and surfaced lumber.

D. Materials required

1. Overhead projector and screen
2. Rulers or tape measures
3. Lumber - rough and surfaced

II. Presentation of Lesson

A. Motivation

Find out how many students can read a ruler. Those who cannot will be given a board and required to determine its length to 1/16 of an inch. Many will not be able to do this task. Stress the necessity of knowing some basic math in carpentry to determine materials needed, proper construction practices, and costs of construction.

B. Content Outline

1. Importance of learning basic math skills:

   a. Determine lengths and widths of lumber and building material.

   b. Properly measure and cut materials for project construction.

   c. Calculate a bill of materials.

   d. Determine cost for materials used in project construction.

   e. Measure for proper placement of materials on the project.

   f. Determine proper cutting of angles for such items as roof rafters and picture frames.

2. Reading a rule or tape measure

   a. To measure lengths or widths of various types of material, measuring tools such as a folding rule or steel tape are used. These tools are marked off in the U.S. Customary System of fractions of an inch, inches, and feet.

   b. Twelve equal parts, called inches, make a foot of length on the ruler or tape. Each successive foot is clearly marked on each ruler; therefore, 12 inches equals 1 foot.

   c. Each individual unit of a foot, the inch, is denoted by marks or lines that go completely across the surface of the ruler. The distance between these lines is called an inch. Remember that 12 of these units equals 1 foot.

   d. Between the boundary lines that denote a length of 1 inch, there are additional marks or lines that divide the inch into equal parts. This division of the inch allows us to be precise in measuring.

   e. These divisions that segment the inch are denoted by lines of different lengths. How these lines divide the inch can be associated with their different lengths. For example, the longest line that divides the inch segments it into halves.

f. Read the ruler from left to right. The first long mark that divides the inch would indicate one half (½) of an inch. This divides the inch into two equal parts. (Transparency II-2-A)

g. The second longest mark that divides the inch indicates one-fourth (¼) of an inch. This divides the inch into four equal parts. From this division, there is 1/4, 1/2, and 3/4 of an inch. (Transparency II-2-B)

h. The next longest mark divides the inch into eight equal parts. It is called one-eighth (1/8) of an inch. From this division, we can measure to 1/8, 1/4, 3/8, 1/2, 5/8, 3/4, and 7/8 of an inch when determining proper lengths or width. (Transparency II-2-C)

i. The smallest mark that divides the inch into equal parts indicates one-sixteenth (1/16) of an inch. The segments divide the inch into 16 equal parts. From this division, a person can measure a 1/16, 1/8, 3/16, 1/4, 5/16, 3/8, 7/16, 1/2, 9/16, 5/8, 1/16, 3/4, 13/16, 7/8, and 15/16 or an inch. (Transparency II-2-D)

j. From these divisions of an inch, a builder can measure a distance or length to a fraction of an inch. This will allow one to be precise and more accurate when estimating costs and building a project.

k. For example, find the following lengths on a rule:

1) 1 foot
2) 6 inches
3) 9 inches
4) 1/2 inch
5) 1/4 inch
6) 1/8 inch
7) 3/8 inch
8) 7/16 inch

9) 3 feet 6 inches
10) 2 feet 10 inches
11) 3 feet 4½ inches
12) 1 foot 6 3/4 inches

3. Adding feet and inches

a. When adding feet and inches, it is important to remember that 12 inches equals 1 foot.

b. When adding inches, it is possible to calculate a figure greater than 12 inches such as 18 inches. To get the inches into feet and inches, simply remove 12 inches from the total inches and change that figure to 1 foot. In this case, 18 inches equals 1 foot and 6 inches.

c. Example:

$$\begin{array}{rrlrl}
 & 5 & \text{feet} & 8 & \text{inches} \\
+ & 6 & \text{feet} & 10 & \text{inches} \\
\hline
 & 11 & \text{feet} & 18 & \text{inches} \\
+ & 1 & \text{foot} & 12 & \text{inches} \\
\hline
 & 12 & \text{feet} & 6 & \text{inches}
\end{array}$$

4. Determining square feet

a. Calculation of square feet is especially important in larger construction such as a house or barn. Square footage is important in determining cooling and heating requirements, lighting requirements, building material requirements, and estimated building costs.

b. Calculation of square feet is done by multiplying the length of the building by the width. This is usually computed using the dimension of the floor space of the structure or the amount of floor space under roof. For example, to calculate square feet of a building with floor dimensions of 45 feet by 32 feet, simply multiply.

45 feet x 32 feet = 1,440 square feet

Calculate square footage for floor space with the following dimensions:

52 feet by 65 feet
100 feet by 60 feet
45 feet by 140 feet

5. Angles

   a. Anytime there is a structural member that extends from the horizontal or vertical plane of a structure, an angle is formed.

   b. Usually primary consideration is given to angles on roof framing when varying slopes are encountered (See Unit V, Lesson 3: Cutting Rafters).

   c. When an angle from the horizontal or vertical plane is straight or plumb, it is called a 90° angle or a right angle. This angle is important when considering roof pitch or getting walls and floors plumb and level.

6. Lumber dimensions and sizes

   a. After trees are cut, the logs must be debarked or "peeled" and prepared for sawing. The logs are cut using a coarse toothed saw. The lumber is very rough as a result.

   b. This rough lumber has been cut to the exact dimension desired. For example, a board cut 2 inches by 4 inches will be a full 2 inches thick by 4 inches wide. Some shrinkage will occur during seasoning or drying.

   c. After grading and drying, softwoods are surfaced in a planing mill and cut into standard sizes. Most standard softwoods are surfaced on four sides, making smooth lumber.

   d. When these boards are surfaced, they are no longer as wide or as thick as they were. They are surfaced to standard thicknesses and widths. A 1 inch stack is now 3/4-inch thick. A 2 inch stack is now actually 1½-inch thick. Four-inch widths and thicknesses are now actually 3½ inches. Six-inch widths are actually 5½ inches.

e. Even though there is a loss in dimension, reference is still made to the various lumber sizes in terms of the rough cut size. For example, a surfaced board 1½ inches x 3½ inches will still be referred to as a 2x4. Other sized boards will be referred to in the same way depending on the size. (Transparency II-2-E)

f. Standard sized boards are necessary so the construction industry can easily draw plans, estimate costs, and build structures. They can do this because they know that lumber will always be the same size.

7. Building material units of measure

   a. Various units of measure are used to denote standard weights, lengths, and widths depending on the type of material.

   b. For example, Information Sheets A, B, and C give the standard lengths and weights for nails and drill bits.

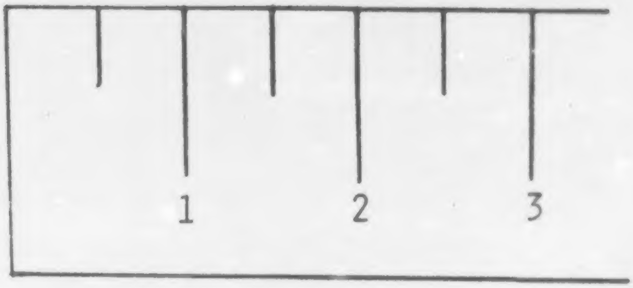
   c. Having a knowledge of units of measure of the various types of building materials and fasteners will aid the builder in determining material needs and costs.

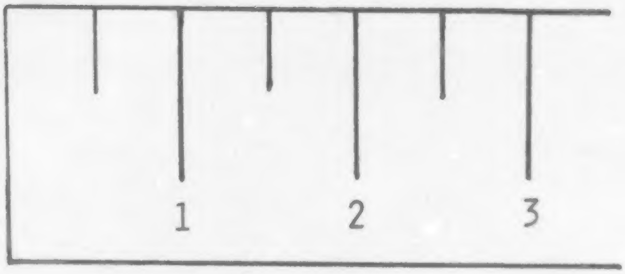
C. Suggested Student Activities

1. The students can engage in reading the tape measure to determine lengths and/or widths of lumber. This type of exercise will be at the discretion of the instructor.

2. Assign students problems to determine the square footage in structures.

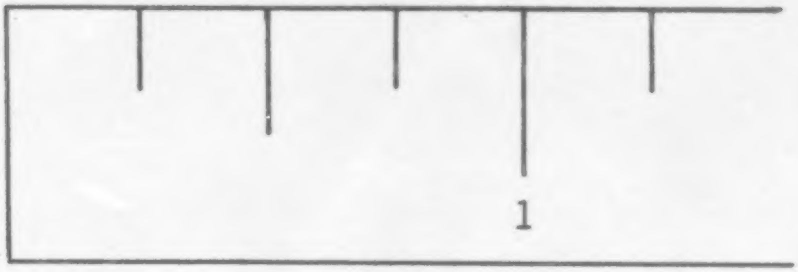
HALVES

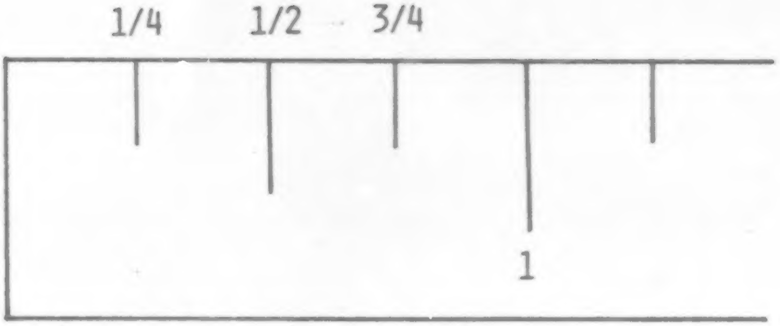




TRANSPARENCY II-2-A

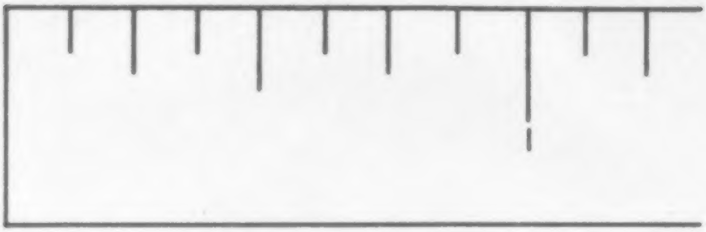
QUARTERS



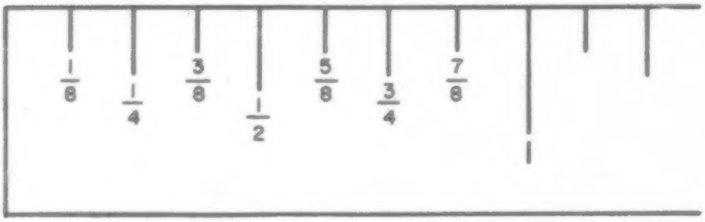


TRANSPARENCY II-2-B

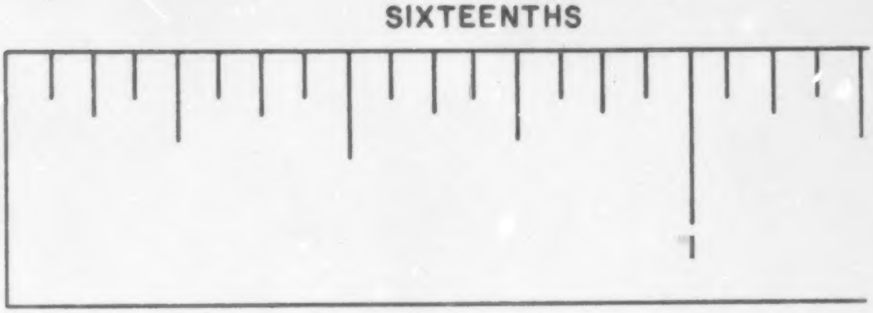
EIGHTHS

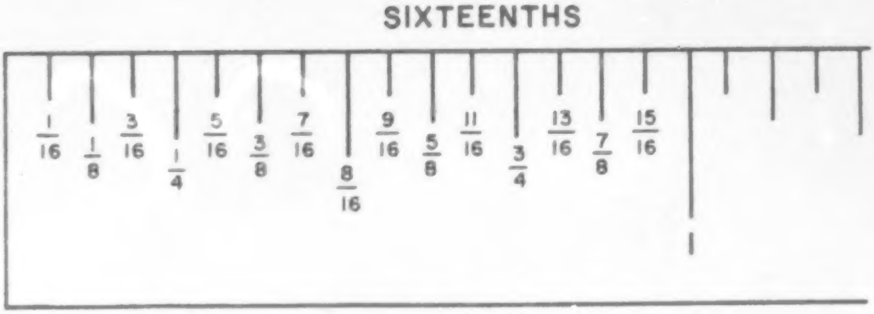


EIGHTHS


1/8
1/4
3/8
1/2
5/8
3/4
7/8
1

TRANSPARENCY II-2-C


SIXTEENTHS


SIXTEENTHS
1/16
1/8
3/16
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3/8
7/16
8/16
9/16
5/8
11/16
3/4
13/16
7/8
15/16
1

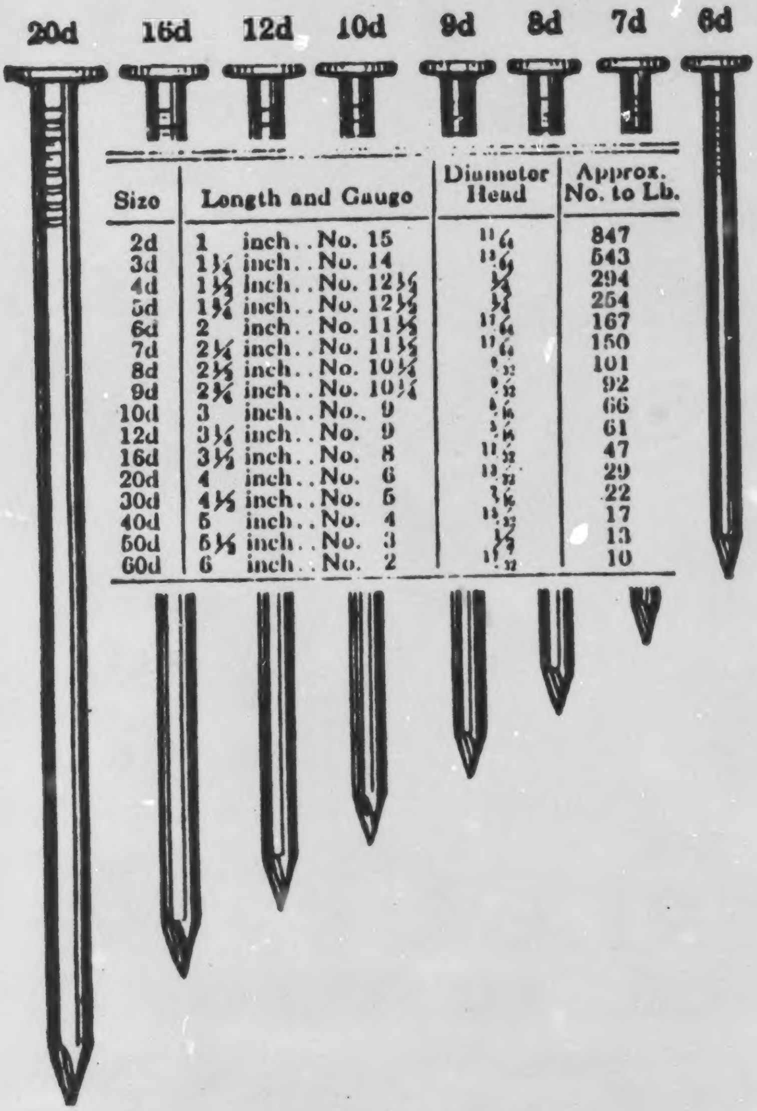
TRANSPARENCY II-2-D

LUMBER DIMENSIONS

TYPE OF LUMBER	ROUGH SIZE (IN.) (SAWMILL CUT)	ACTUAL SIZE (IN.) (S 4 S)
Square Edge Boards	1 x 4	$\frac{25}{32}$ x 3 5/8
	1 x 6	$\frac{25}{32}$ x 5 5/8
	1 x 8	$\frac{25}{32}$ x 7 1/2
	1 x 10	$\frac{25}{32}$ x 9 1/2
	1 x 12	$\frac{25}{32}$ x 11 1/2
Framing	2 x 4	1 5/8 x 3 5/8
	2 x 6	1 5/8 x 5 5/8
	2 x 8	1 5/8 x 7 1/2
	2 x 10	1 5/8 x 9 1/2
	2 x 12	1 5/8 x 11 1/2
	4 x 4	3 5/8 x 3 5/8
	6 x 6	5 1/2 x 5 1/2

Transparency II-2-E

INFORMATION SHEET A



Size	Length and Gauge	Diameter Head	Approx. No. to Lb.
2d	1 inch. . No. 15	11/64	847
3d	1¼ inch. . No. 14	13/64	543
4d	1½ inch. . No. 12½	¼	294
5d	1¾ inch. . No. 12½	¼	254
6d	2 inch. . No. 11½	17/64	167
7d	2¼ inch. . No. 11½	17/64	150
8d	2½ inch. . No. 10¼	9/32	101
9d	2¾ inch. . No. 10¼	9/32	92
10d	3 inch. . No. 9	5/16	66
12d	3¼ inch. . No. 9	5/16	61
16d	3½ inch. . No. 8	11/32	47
20d	4 inch. . No. 6	13/32	29
30d	4½ inch. . No. 5	7/16	22
40d	5 inch. . No. 4	15/32	17
50d	5½ inch. . No. 3	½	13
60d	6 inch. . No. 2	17/32	10

INFORMATION SHEET B

SIZE, LENGTH, GAUGE AND APPROXIMATE NUMBER OF NAILS PER POUND[1]

	COMMON			BOX NAILS		FINISHING	
Size	Length in inches	Gauge	No. per Lb.	Gauge	No. per Lb.	Gauge	No. per Lb.
2d.	1	15	876	15½	1010	16½	1351
3d.	1¼	14	568	14½	635	15½	807
4d.	1½	12½	316	14	473	15	584
5d.	1 3/4	12½	271	14	406	15	400
6d.	2	11½	181	12½	236	13	309
7d.	2¼	11½	161	12½	210	13	239
8d.	2½	10¼	106	11½	145	12½	189
9d.	2 3/4	10¼	96	11½	132	12½	172
10d.	3	9	69	10½	94	11½	121
12d.	3¼	9	63	10½	88	11½	113
16d.	3½	8	49	10	71	11	90
20d.	4	6	31	9	52	10	62
30d.	4½	5	24	9	46		
40d.	5	4	18	8	35		
50d.	5½	3	14				
60d.	6	2	11				

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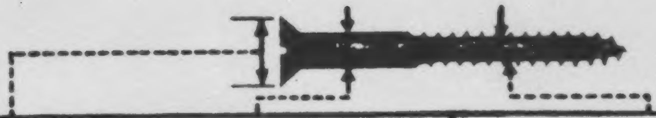
[1] "Manual of Carpentry," American Steel and Wire Company, Chicago.

INFORMATION SHEET C



NO. OF SCREW	MAXIMUM HEAD DIAMETER	SHANK DIAMETER		ROOT DIAMETER		THREADS PER INCH	NO. OF SCREW
		BASIC DEC. SIZE	NEAREST FRACTIONAL EQUIVALENT	AVERAGE DEC. SIZE	NEAREST FRACTIONAL EQUIVALENT		
0	.119	.060	1/16 OVERSIZE .002	.040	3/64 OVERSIZE .007	32	0
1	.146	.073	5/64 OVERSIZE .005	.046	3/64 BASIC SIZE	28	1
2	.172	.086	3/32 OVERSIZE .007	.054	1/16 OVERSIZE .008	26	2
3	.199	.099	7/64 OVERSIZE .010	.065	1/16 UNDERSIZE .002	24	3
4	.225	.112	7/64 UNDERSIZE .003	.075	5/64 OVERSIZE .003	22	4
5	.252	.125	1/8 BASIC SIZE	.085	5/64 UNDERSIZE .007	20	5
6	.279	.138	9/64 OVERSIZE .002	.094	3/32 BASIC SIZE	18	6
7	.305	.151	5/32 OVERSIZE .005	.102	7/64 OVERSIZE .007	16	7
8	.332	.164	5/32 UNDERSIZE .007	.112	7/64 UNDERSIZE .003	15	8
9	.358	.177	11/64 UNDERSIZE .005	.122	1/8 OVERSIZE .003	14	9
10	.385	.190	3/16 UNDERSIZE .002	.130	1/8 UNDERSIZE .005	13	10
11	.411	.203	13/64 BASIC SIZE	.139	9/64 OVERSIZE .001	12	11
12	.438	.216	7/32 OVERSIZE .003	.148	9/64 UNDERSIZE .007	11	12
14	.491	.242	1/4 OVERSIZE .008	.165	5/32 UNDERSIZE .009	10	14
16	.544	.268	17/64 UNDERSIZE .002	.184	3/16 OVERSIZE .003	9	16
18	.597	.294	19/64 OVERSIZE .003	.204	13/64 UNDERSIZE .001	8	18
20	.650	.320	5/16 UNDERSIZE .007	.223	7/32 UNDERSIZE .004	8	20
24	.756	.372	3/8 OVERSIZE .003	.260	1/4 UNDERSIZE .010	7	24

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT II: Woodworking

LESSON 3: Preparing and Using Working Drawings

I. Preparation for Instruction

A. Objectives

1. Terminal: Prepare and read working drawings.

2. Specific:

a. Explain the need for working drawings.
b. List and describe the basic drawing equipment.
c. Demonstrate the proper method of attaching drawing paper to the drawing board.
d. Demonstrate the proper method for laying out the margin and title block on drawing paper.
e. Describe the different weights and uses of lines in drawing.
f. Demonstrate the use of the architect's scale.
g. List and describe the three views of objects.
h. Demonstrate the procedure for dimensioning a drawing of an object.
i. Describe the procedure for reading working drawings.
j.

k.

l.

B. Review Teaching Material

1. McCoy, V.L. and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

2. Phipps, L.J. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

C. Special Arrangements

Make arrangements to view some small building on the school grounds that the students can scale down and draw on paper. The students will measure the object during the exercise to get the proper dimensions for the drawing.

D. Materials required

1. Drawing equipment

2. Drawing paper

II. Presentation of Lesson

A. Motivation

Bring a simply constructed wooden box to class. Ask the students if they could construct one just like it. Demonstrate the need for a working drawing of an object for construction purposes if the object itself is not present.

B. Content Outline

1. Introduction

   a. Prior to beginning any project, planning is essential for successful completion. An integral part of the planning process in project construction is the development of a drawing or sketch of that project.

   b. Reasons for having project drawings or sketches:

      1) Essential for calculating a bill of materials.

      2) Aid in estimating size and shape of the project. This may cause the designer to change the design of a project.

      3) Reading a set of drawings will allow an individual to build projects from plans drawn by other people.

      4) A good plan aids the shop worker to complete the project with the least expense of time, money, and materials.

2. Types of drawings

   a. A sketch is a rough outline of an object. It is usually done freehand and is not drawn to scale. For small simple projects, a neat sketch may be sufficient; however, larger, complicated objects will require a precise mechanical drawing.

   b. A mechanical drawing is done with drawing instruments and equipment designed to give the drawing precise lines and dimensions.

3. Sketching and drawing equipment (Transparencies II-3-A, B and C)

   a. Drawing board -- A board 20 inches by 26 inches will accommodate paper 17 inches by 22 inches which is suitable for most drawings. The left edge of the board must be straight so that the blade of the T-square will form a true right angle.

b. T-square -- A T-square is made of hardwood with a head fixed at a 90 degree angle to the long blade. The head of the T-square slides along the left edge of the drawing board. The blade serves as a straightedge for drawing horizontal lines.

c. Triangles -- Two different triangles are needed. One is a 45 degree triangle and the other is a 30 degree by 60 degree triangle.

d. Scales -- Scales are measuring instruments used to draw an object smaller than its actual size but in the same proportion. The scale most used is the architect's scale. This scale is used to allow certain parts of an inch to represent a unit of measure of the actual object. For example, one scale is 1/8 inch = 1 foot. This means that 1/8 inch on the drawing actually refers to 1 foot on the object.

e. Protractor -- The protractor measures the degrees of angles so that angles may be drawn accurately.

f. Pencils -- Drawing pencils are made in 18 degrees of hardness. The most commonly used ones are the medium-soft B, 4B, and F for sketches and lettering, and the harder H, 2H, and 3H for drawings.

g. Compasses, dividers, and bow instruments -- A compass is used to draw circles and arcs. Dividers are used to transfer measurements and spacings from one drawing to another. Bow instruments are smaller and do the same tasks as the compass and divider but are much more accurate for distances of one inch or less.

h. Miscellaneous

   1) There are two kinds of erasers needed. An art gum for cleaning

smudges and red rubber for removing pencil lines.

2) Drafting tape is used for fastening paper to the drawing board.

4. Basic procedures for mechanical drawing (Transparency II-3-D)

   a. Attach paper to the drawing board with tape after squaring the bottom of the paper with the top of the T-square. Leave approximately a 2 inch margin at top and left (top and right for lefthanders).

   b. Penciling

      1) Keep the pencil sharp at all times. This will aid in getting a uniform line thickness from end to end.

      2) For neat appearance and easy erasing make all lines and markings so light that they can barely be seen. Darken when the last detail has been drawn.

      3) The lines vary in intensity or weight as to their uses. Line use determines how "heavy" or "light" the line should appear. (Transparency II-3-E)

   c. Lay out the margin on title block (Transparency II-3-F)

      1) Lay out a border to frame the drawing.

      2) Lay out the title block using the appropriate dimensions as shown in Transparency II-3-F. Use a 4H or 5H hard pencil to make the first lines very light. Darken with an H or 2H lead pencil.

   d. Horizontal, vertical, and inclined lines (Transparency II-3-G)

      1) Draw horizontal lines from left to right (right to left for left-handers) along the top edge of the T-square.

2) Vertical lines are drawn straight up with a triangle against the T-square.

3) Inclined lines are drawn with individual triangles or with combinations of two triangles. At least one triangle should always be placed against the top edge of the T-square. (Transparency II-3-H)

e. Using the scale

1) Most objects cannot be drawn their actual size. Therefore, it becomes necessary to draw the object to a smaller scale by using a fraction of an inch to represent the unit of measure on the object.

2) To draw an object to scale, measure it, calculate the length of the lines according to the scale. Place the scale along the line to be drawn and mark a short dash perpendicular to the scale. Remove the scale and draw the line. Do not use the scale as a straightedge. (Transparency II-3-I)

f. Lettering

1) On the drawing, keep lettering and dimensions outside the view itself. Lower case letters and italic letters are almost never used. (Transparency II-3-J)

2) Set up horizontal guidelines 1/8 inch apart for the largest letters. Use a 4H or 6H sharp pencil and draw the lines very lightly because they will not be erased. These lines aid in keeping letters in proper alignment.

3) Neat, attractive lettering can be achieved through patient practice.

5. Views of objects

a. Orthographic drawing (Transparency II-3-K and L)

1) The orthographic drawing provides the viewer three different perspectives on an object -- front, top, and side.

2) The front is usually the basic view. The front view is selected on the basis of the side that has the longest dimensions and shows the characteristic shapes.

3) Dimensioning (Transparency II-3-M)

   a) Extension line -- The extension line continues an object line or a center line outside the object itself. Leave about a 1/16-inch gap between the object and the extension line.

   b) Dimension line -- A dimension line connects, at right angles, two extension lines. There is a gap in the middle for a dimension figure and an arrowhead at each end. Dimension lines should be ¼ inch apart and the first one should be ¼ inch from the object.

   c) Leader -- this line is drawn from a horizontally lettered note or dimension to a detail when extension lines cannot be drawn. It should be drawn in a straight, inclined line.

   d) Figures -- Place figures so that they can be read from the bottom edge and/or right edge of the drawing.

   e) Inch marks -- In general, give measurements through 72 inches in inches only. Above 72 inches, state measurements in feet and inches.

b. Pictorial drawings

1) Oblique -- The oblique view is based on a three-axes principle:

one vertical and one horizontal, with a third axis at a convenient angle to the horizontal. This angle is usually 15 degrees, 30 degrees, or 95 degrees.

2) Isometric -- This view is based on a three-axes principle: one vertical axis, with two others at 120 degrees to the vertical. (Transparency II-3-N).

6. Reading plans

   a. Glance over the plan to gain a general idea of the shape of the object.

   b. Study the view that shows the most characteristic shape. Refer to the other views to check what each line represents.

   c. When reading dimensions, look at the scale of the drawing to get an idea of the object's actual size. Make sure the proper dimension lines are being read for each dimension noted. If the dimension of a particular part is not in one view, look for it on another.

   d. Standard symbols are used in denoting various types of construction materials. These are called section-lining symbols. (Transparency II-3-O)

C. Suggested Student Activities

1. Provide each student with drawing equipment and supplies. Allow each student to practice the proper method for placing the paper on the drawing board. In addition, each student should be given practice in drawing lines using the T-square and triangles.

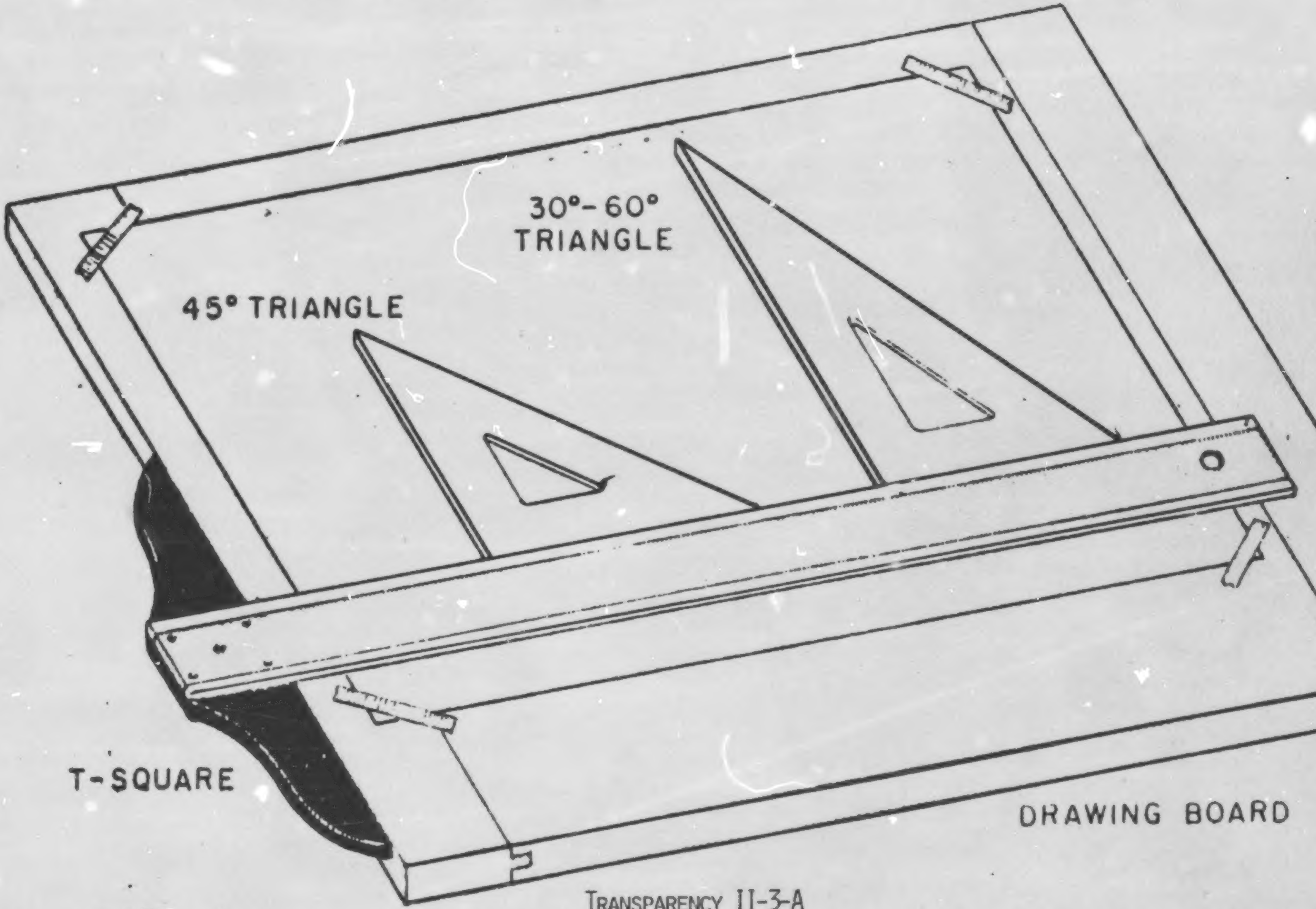
2. Give each student a prepared orthographic drawing to be drawn on the individual's paper to the same scale. The object should be dimensional and line quality should be checked.

3. Provide a wooden block model of a simple object. Have each student measure the object for dimensions and draw orthographic, isometric, and oblique drawings with dimensions.

4. Provide each student with a prepared drawing with dimensions. Each student will read the drawing and tell the instructor about the object with regard to size and shape.

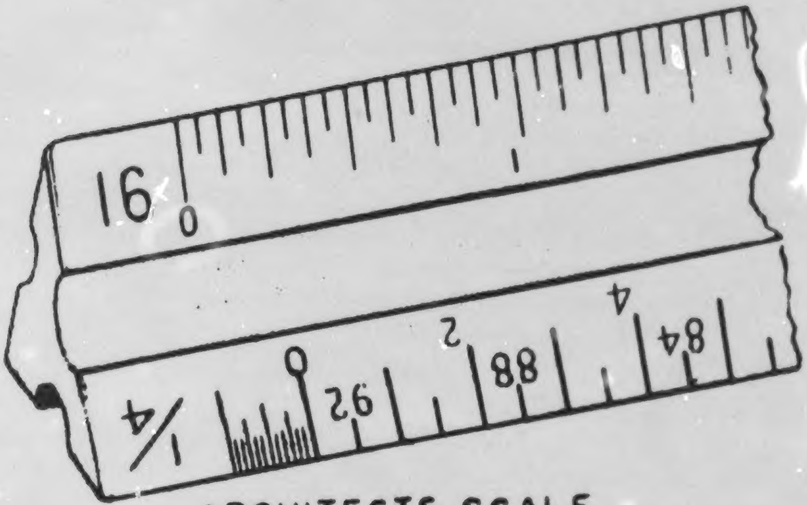
5. Take the class to a small building on the school campus and acquire dimensions and a sketch of the structure. Each student will draw, to scale, an orthographic and isometric drawing of the structure including dimensions.

BASIC MECHANICAL DRAWING EQUIPMENT

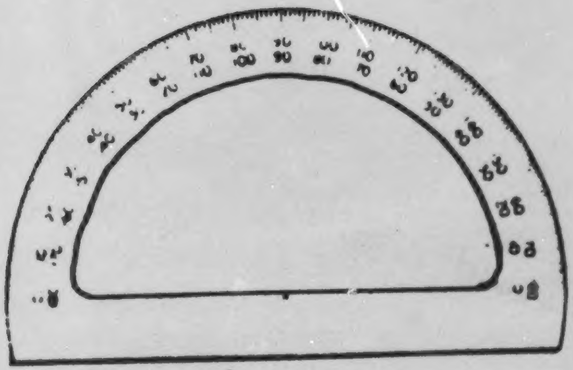

30°-60° TRIANGLE
45° TRIANGLE
T-SQUARE
DRAWING BOARD

TRANSPARENCY II-3-A

BASIC MECHANICAL DRAWING EQUIPMENT


16
0
1
1/4
0
92
2
88
4
84

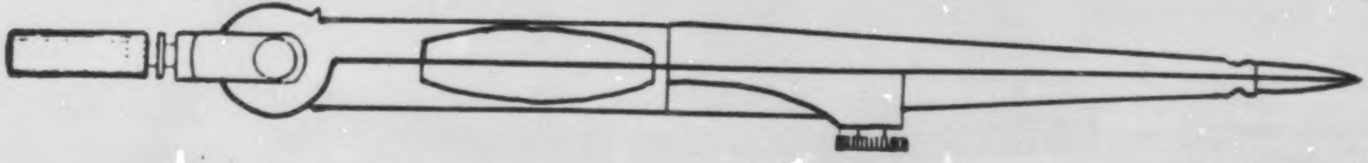
ARCHITECTS SCALE



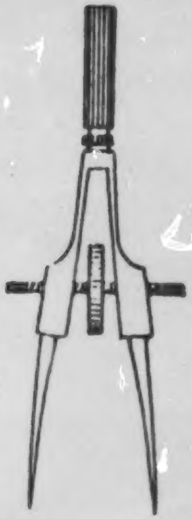
PROTRACTOR

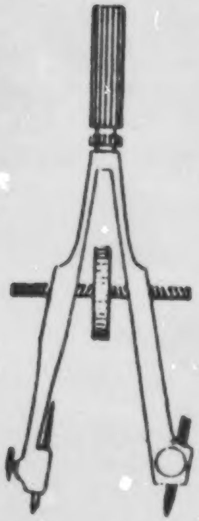
TRANSPARENCY II-3-B

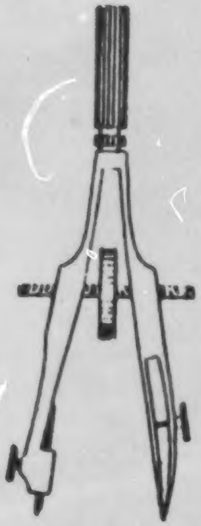
BASIC MECHANICAL DRAWING EQUIPMENT


DIVIDERS

BOW DIVIDERS

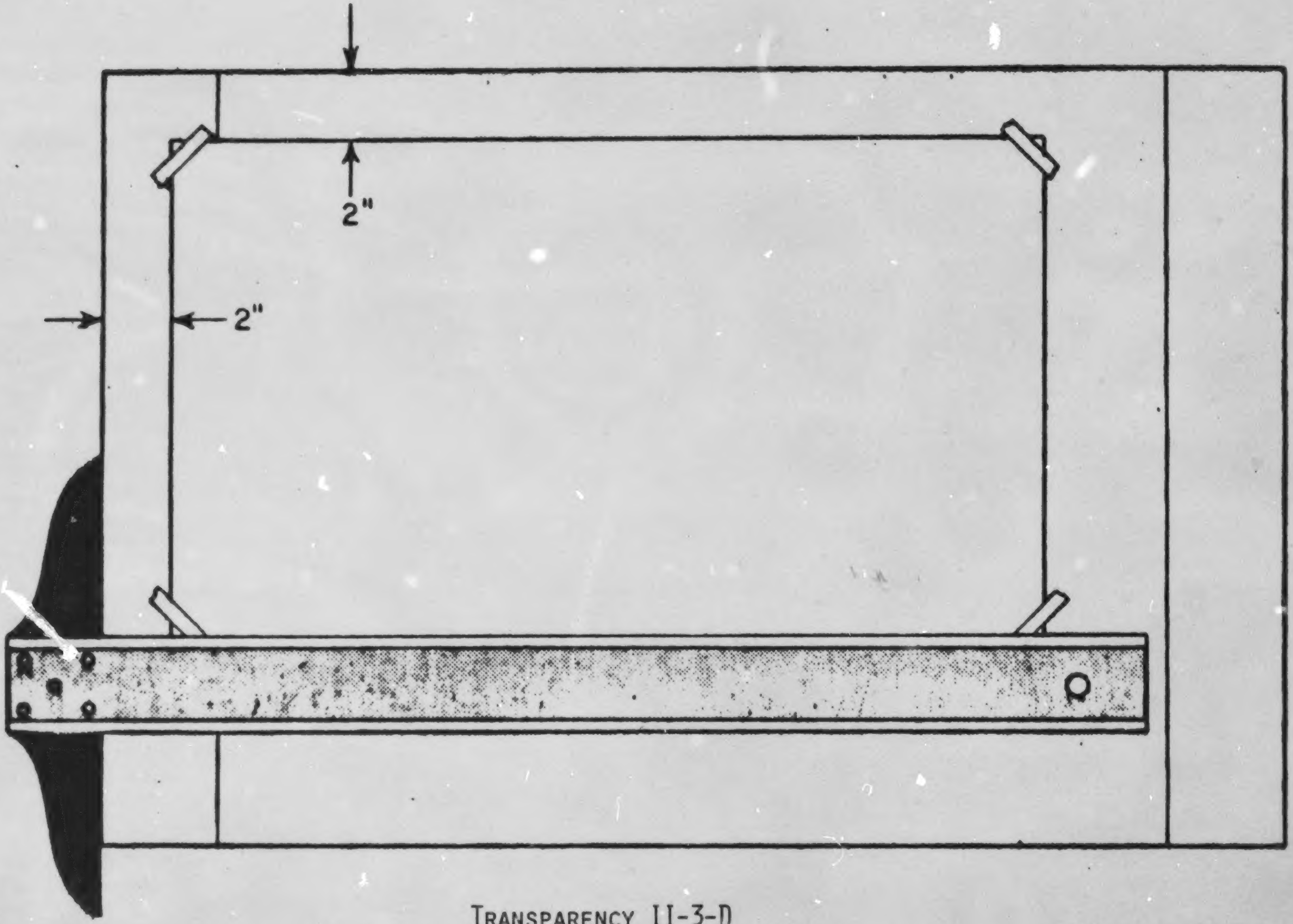



BOW PENCIL


BOW PEN

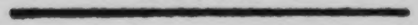
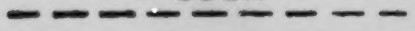
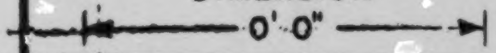
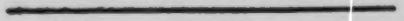
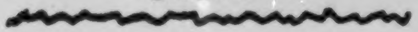
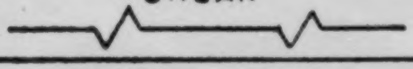
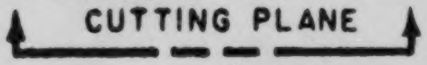
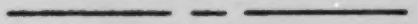
TRANSPARENCY II-3-C

PROPER ATTACHMENT OF PAPER TO DRAWING BOARD



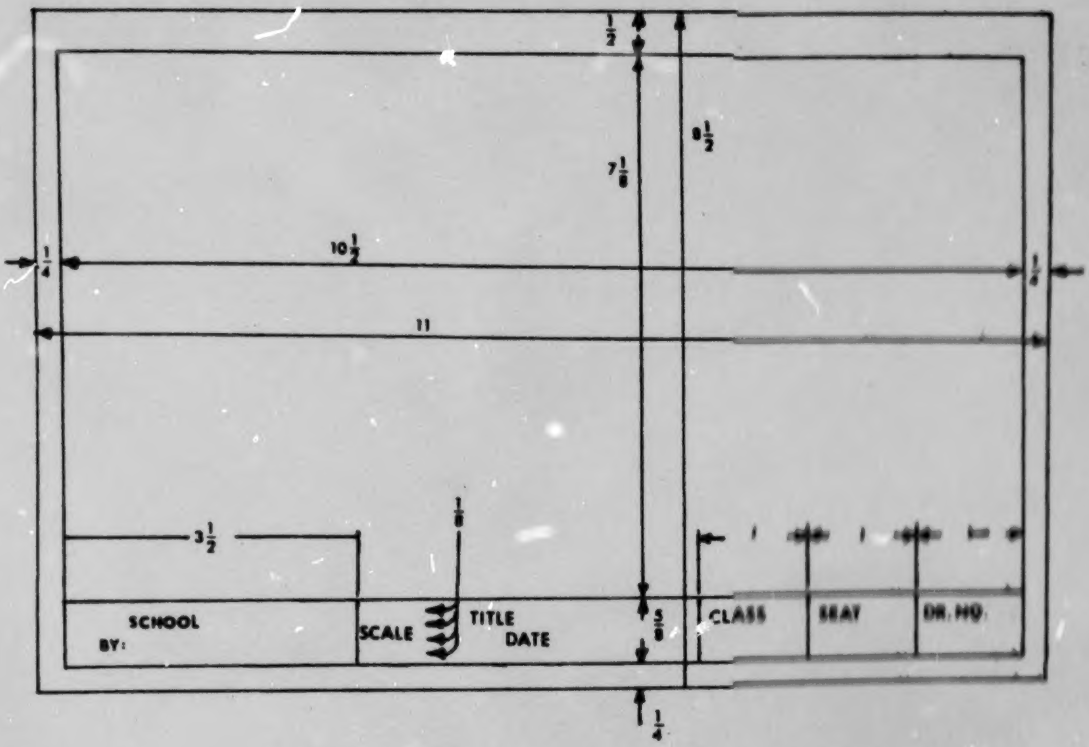
TRANSPARENCY II-3-D

LINES, WEIGHTS, AND USES

LINES	*WEIGHT*	*USE*	*PENCIL NO*
BORDER 	VERY HEAVY	TO FRAME A DRAWING	H
OBJECT 	HEAVY	TO SHOW VISIBLE EDGES	2 H
HIDDEN 	MEDIUM	TO SHOW HIDDEN EDGES	2 H
DIMENSION  	LIGHT	DIMENSIONING	3 H
EXTENSION 	LIGHT	TO INDICATE THE EXTENT OF A MEASUREMENT GIVEN BY A DIMENSION LINE	3 H
BREAK 	HEAVY	SHORT BREAKS	2 H
BREAK 	LIGHT	LONG BREAKS	2 H
CUTTING PLANE 	VERY HEAVY	TO SHOW CUTTING PLANE	H
CENTER LINE 	VERY LIGHT	TO SHOW CENTERS	3 H

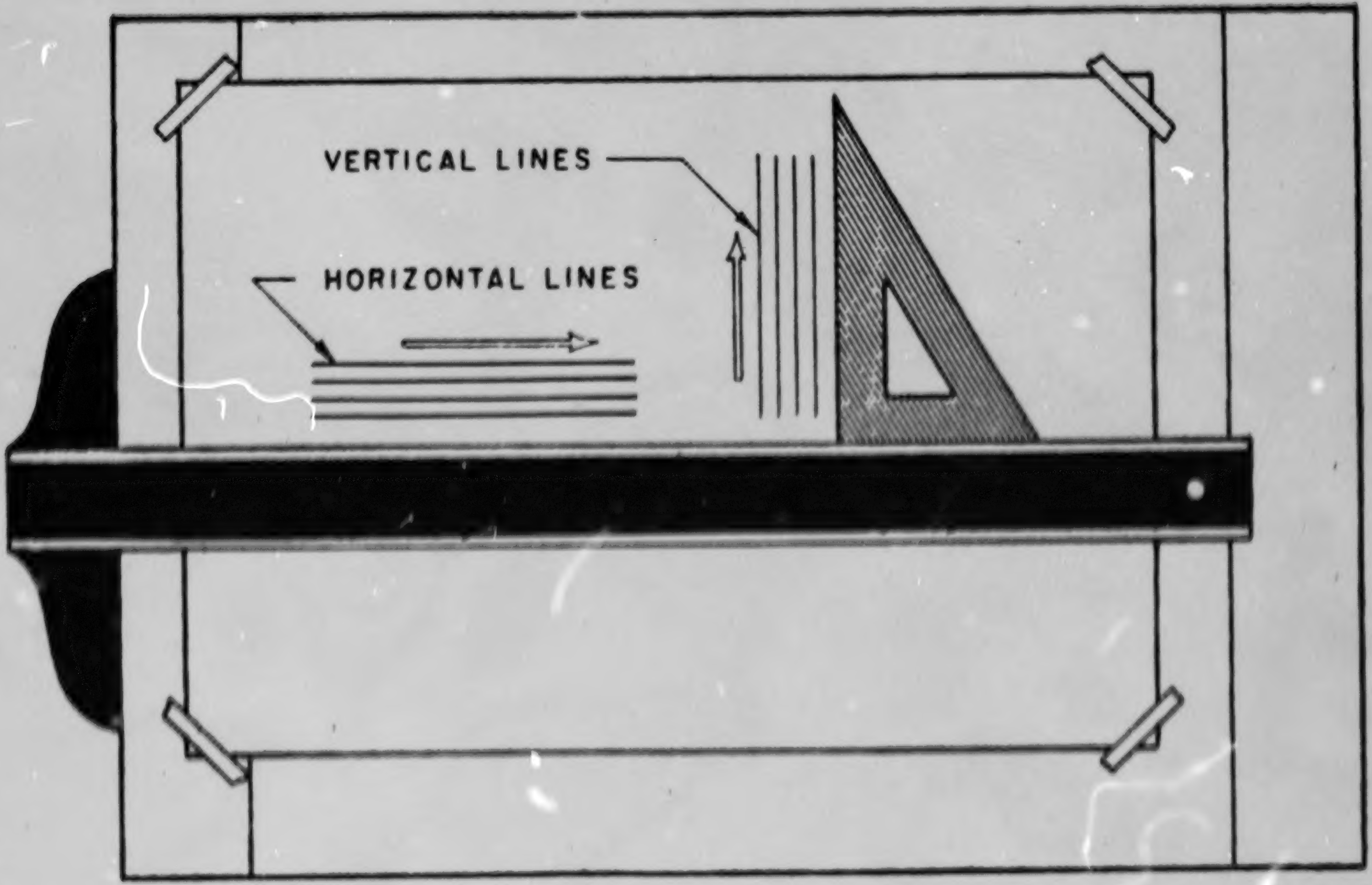
TRANSPARENCY II-3-E

BORDER AND TITLE BLOCK LAYOUT


1/2
8 1/2
7 1/8
1/4
10 1/2
1/4
11
3 1/2
1/8
1
1
1
SCHOOL
BY:
SCALE
TITLE
DATE
5/8
CLASS
SEAT
DR. NO.
1/4

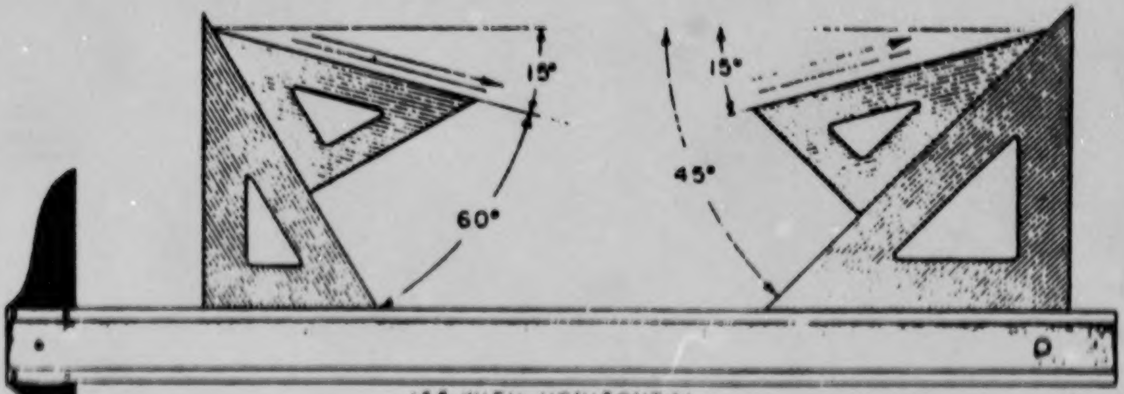
TRANSPARENCY II-3-F

DRAWING HORIZONTAL AND VERTICAL LINES

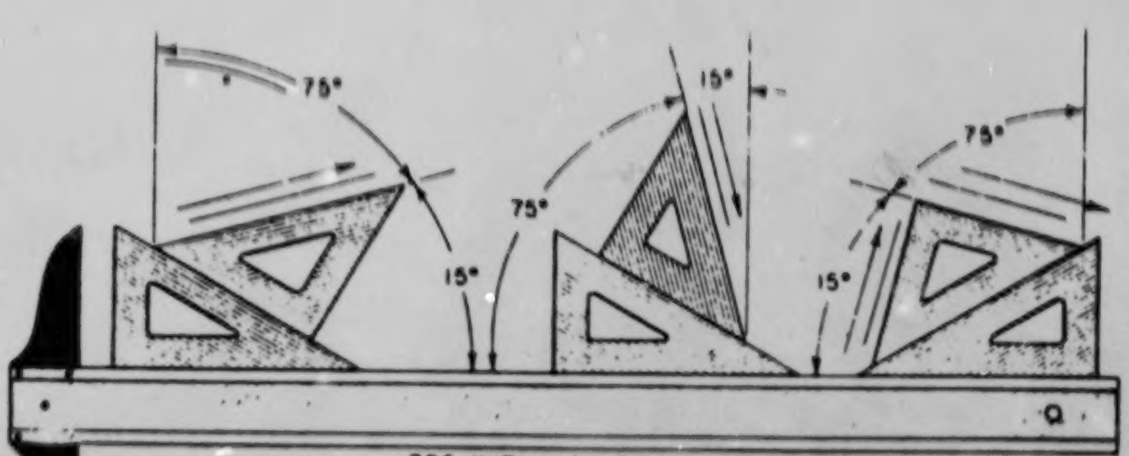

VERTICAL LINES
HORIZONTAL LINES

TRANSPARENCY II-3-G

DRAWING INCLINED LINES



15° WITH HORIZONTAL

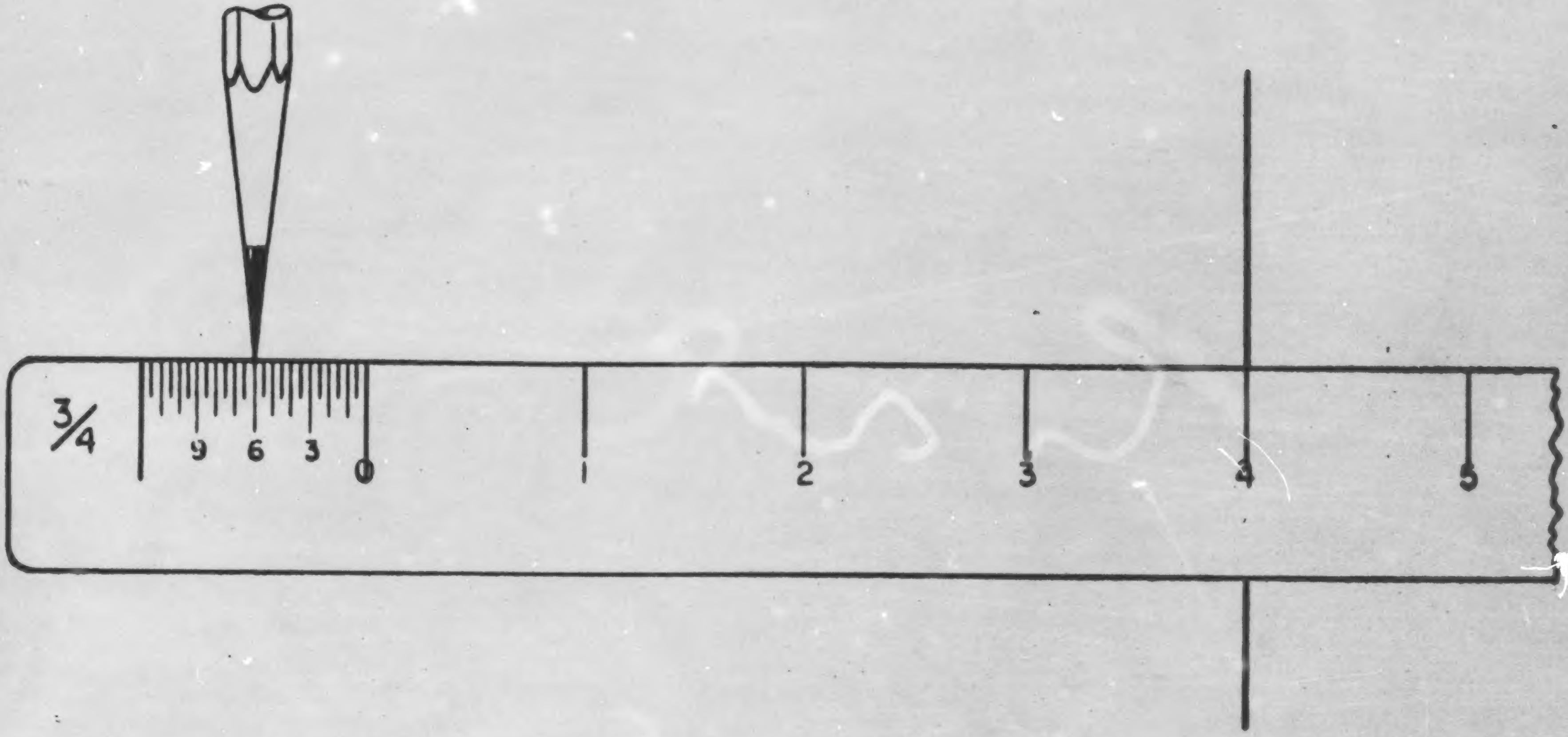


75°
15°
75°
15°
75°
15°

75° WITH HORIZONTAL

TRANSPARENCY II-3-H

USE OF ARCHITECTS' SCALE


3/4
9
6
3
0
1
2
3
4
5

TRANSPARENCY II-3-1

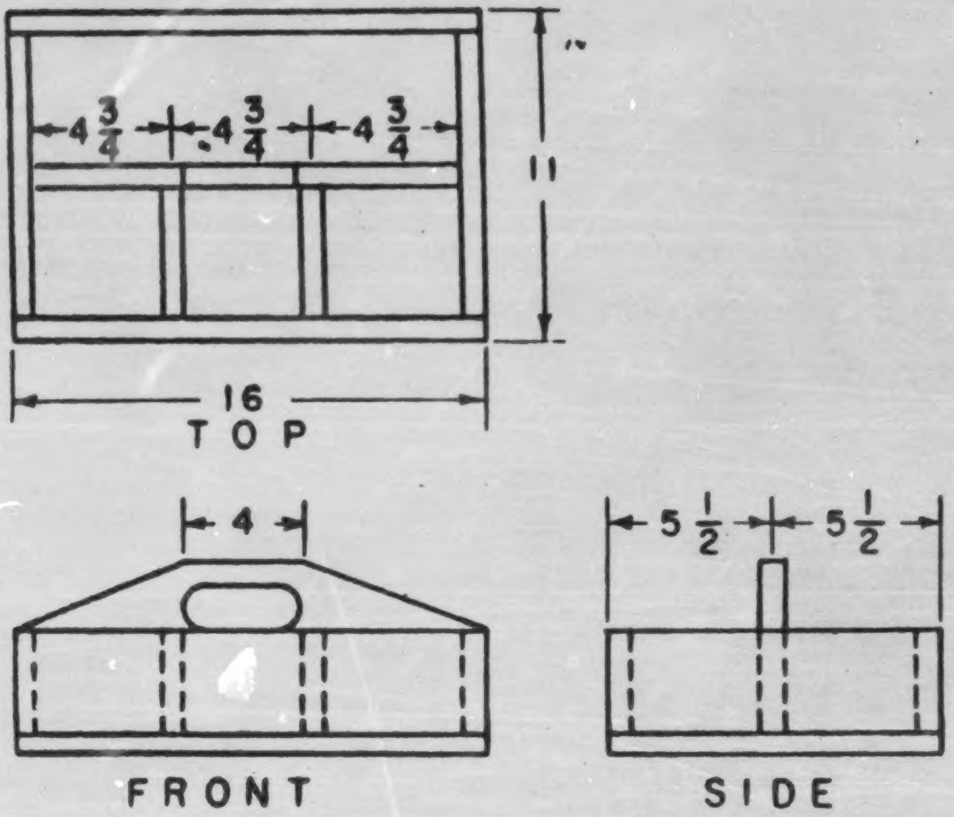
LETTERING AND NUMBERS

ABCDEFGHIJKLMNOP
QRSTUVWXYZ&
1234567890 $\frac{1}{2}$ $\frac{3}{4}$ $\frac{5}{8}$

ABCDEFGHIJKLMNOPQRSTUVWXYZ&
1234567890 $\frac{1}{2}$ $\frac{3}{4}$ $\frac{5}{8}$ $\frac{9}{32}$

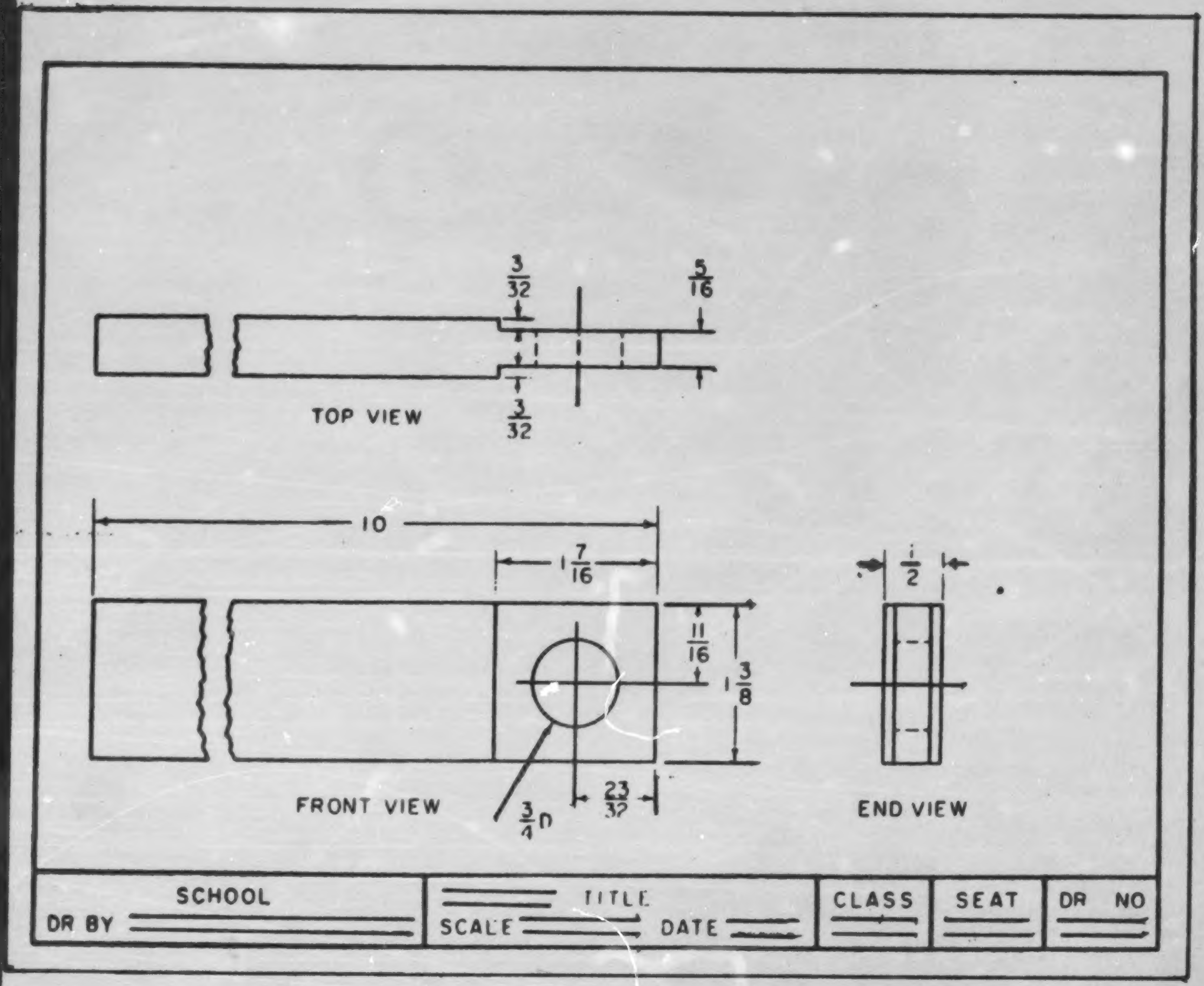
ABCDEFGHIJKLMNOPQRSTUVWXYZ&
1234567890 $\frac{1}{2}$ $\frac{3}{4}$ $\frac{5}{8}$ $\frac{23}{64}$

TRANSPARENCY II-3-J


4 3/4
4 3/4
4 3/4
11
16
TOP
4
FRONT
5 1/2
5 1/2
SIDE

TRANSPARENCY II-3-K

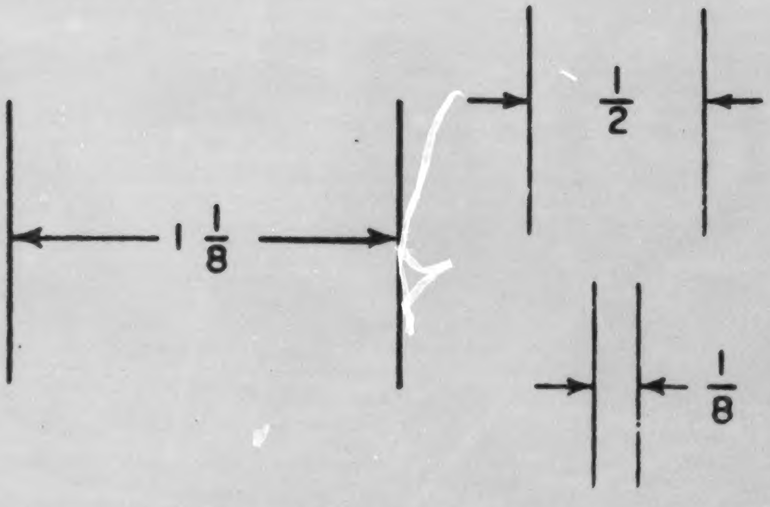
ORTHOGRAPHIC DRAWING


3/32
5/16
TOP VIEW
3/32
10
1 7/16
1/2
11/16
1 3/8
FRONT VIEW
3/4 D
23/32
END VIEW
SCHOOL
DR BY
TITLE
SCALE
DATE
CLASS
SEAT
DR NO

TRANSPARENCY II-3-L

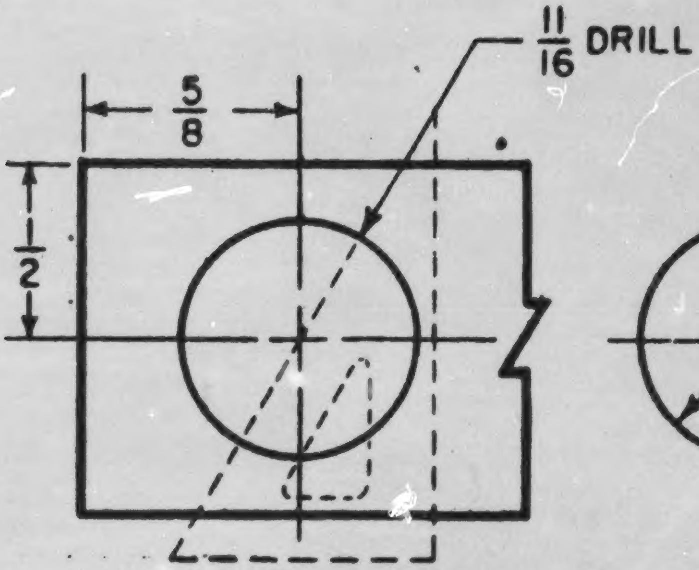
DIMENSIONING LINES

EXTENSION LINES

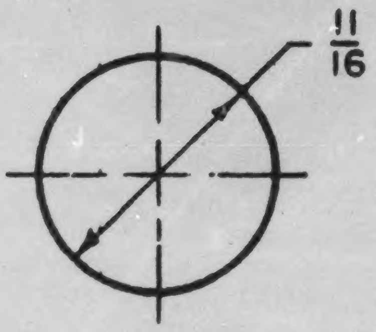


2. DIMENSION LINES

3. LEADER


11/16 DRILL
5/8
1/2

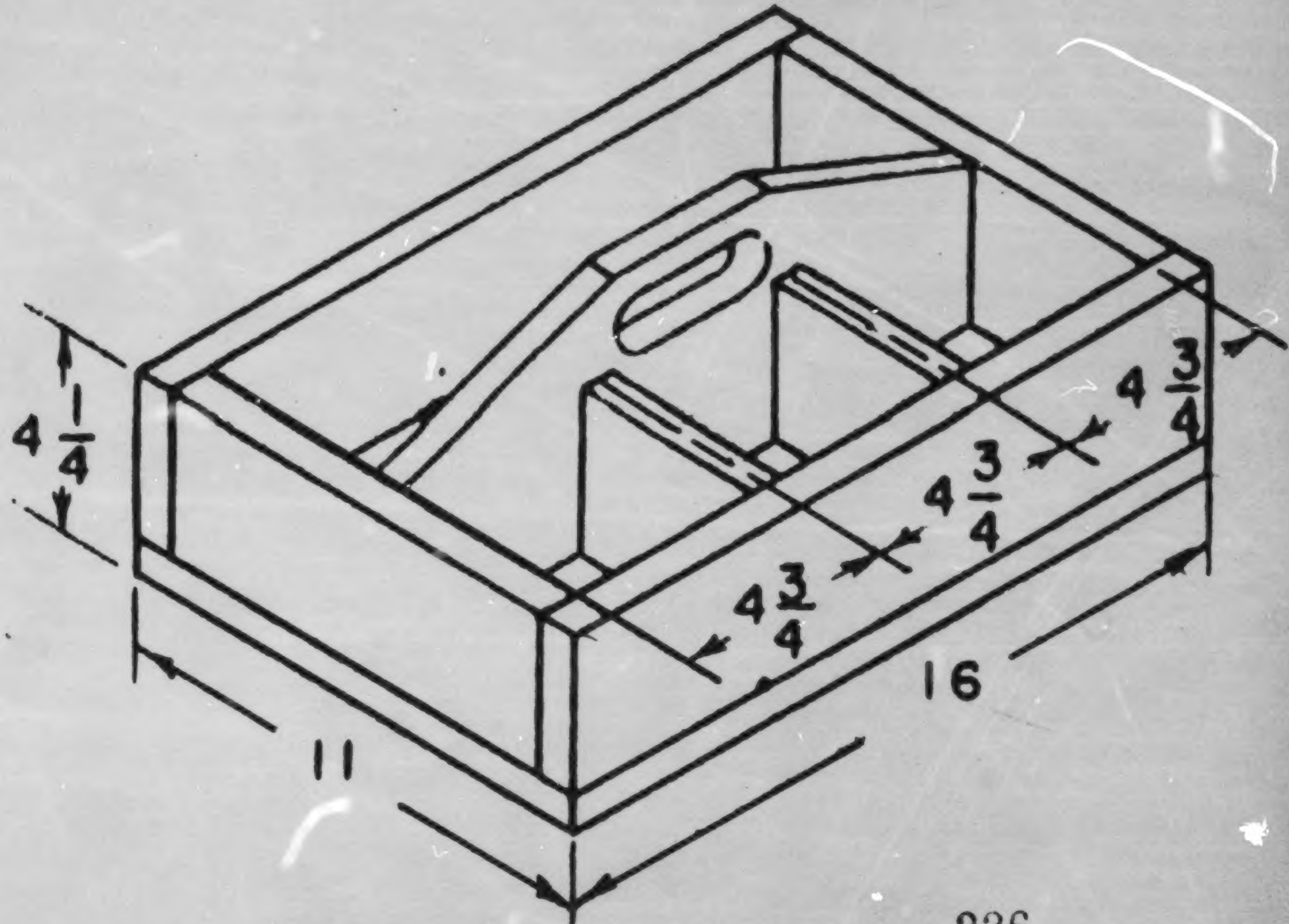
LOCATION AND SIZE OF HOLE



SIZE OF CYLINDER

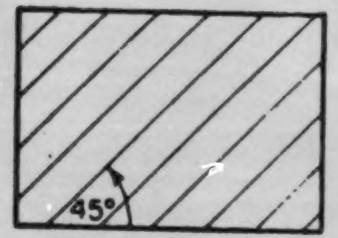
TRANSPARENCY II-3-M

ISOMETRIC DRAWING

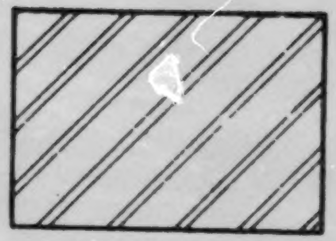

4 1/4
4 3/4
4 3/4
4 3/4
16
11

TRANSPARENCY II-3-N

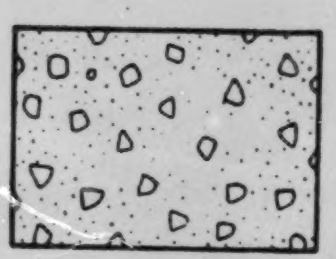
CONSTRUCTION MATERIALS SYMBOLS



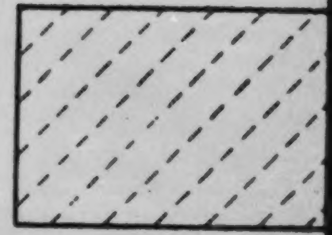
GENERAL PURPOSE



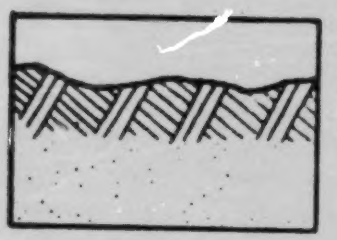
STEEL



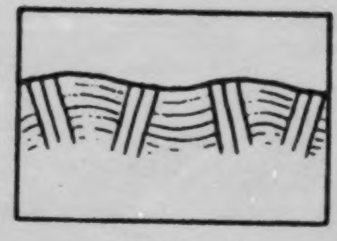
CONCRETE



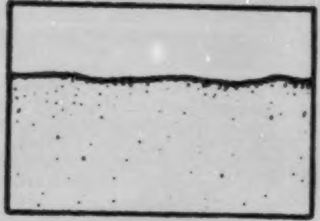
GLASS



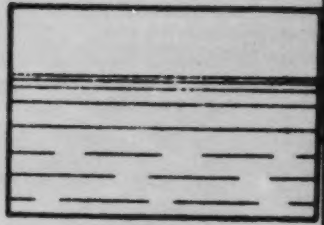
EARTH



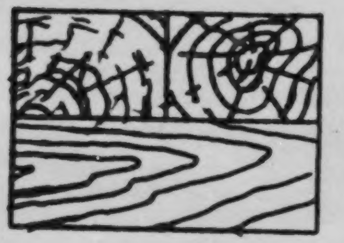
ROCK



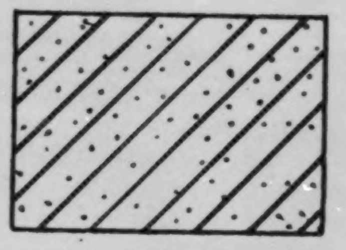
SAND



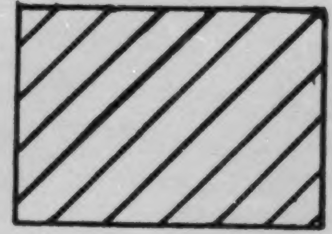
WATER



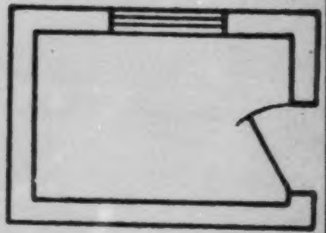
WOOD



BUILDING BLOCK



BRICK AND STONE



WINDOW AND DOOR

TRANSPARENCY II-3-0

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT III: Tool Fitting

LESSON 1: Tools Used in Tool Fitting

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Describe the equipment, accessories, tools, and safety precautions to be used in tool fitting.

2. Specific:

    a. Define the terms associated with tool fitting.
    b. Describe the different types of power grinders.
    c. List specifications needed to purchase a grinding wheel.
    d. List several types of whetstones.
    e. Define the purpose of a template.
    f. Name the parts of a file.
    g. Name the files most commonly used in tool fitting.
    h. Explain the procedure to follow in using a steel.
    i. List the safety rules to follow in using the power grinder and the file.
    j.

    k.

    l.

B. Review of Teaching Materials

1. Phipps, L.S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

2. McCoy, V.L. and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

1. Obtain the hand tool necessary for tool fitting to show to students in the classroom.

2. Prepare a demonstration in the shop with the different types of grinders.

D. Materials required

1. Overhead projector and screen

2. Hand tools associated with tool fitting.

II. Presentation of Lesson

A. Motivation

1. The worker who does not keep tools sharp or otherwise in good repair is risking more than doing a poor job. That worker also risks injury.

2. Poorly fitted tools are not only dangerous to work with, but also they waste both time and materials and produce low quality work. Therefore, the first step in shop work is learning to keep tools in good condition.

3. Cutting tools simply do not perform well when their blades are dull or nicked. They also require the person using them to work harder and less effectively than is desirable or necessary.

B. Content Outline

1. Terms

   a. Tool fitting -- Sharpening, cleaning, dressing, and adjusting tools to do the work they were designed to do.

   b. Power grinder -- Stationary or portable piece of equipment used in tool fitting (Features of power grinders are listed below).

   c. Grinding wheels -- Made of abrasive cutting particles held together by a bonding material. The wheel(s) are located on the power grinder.

   d. Whetstone -- A stone for honing tools.

   e. Hone -- A fine-grained whetstone for giving a keen edge to tools.

   f. Template -- A pattern or gauge such as a thin metal plate with a cut pattern, used as a guide in making something accurately. In tool fitting it is used to measure the correct angle or bevel of the tool to ensure that the tool operates properly.

   g. File -- Any of several steel tools with hardened ridged surfaces, used in smoothing or grinding down.

   h. Steel -- A knife sharpener consisting of a handled steel rod.

   i. Grit -- Texture or structure of the stone to be used in grinding.

2. The power grinder is really a grinding wheel mounted on an electric motor. The electric motor can be classified as either stationary or portable. Therefore, there are stationary and portable types of grinders (Transparency III-1-A). For the purpose of tool fitting, the stationary type of grinder is used most often. There are two types of stationary grinders:

   a. Small bench grinders, and

   b. Larger pedestal grinders. (Transparency III-1-A)

3. Grinding wheels can be purchased in different grits and sizes for various types of work. Specifications needed to purchase a grinding wheel are:

   a. Grit,

   b. Diameter,

   c. Width,

   d. Size of arbor hole (hole in which a bolt or nut is used to secure the grinding wheel to the grinder), and

   e. Maximum speed of the grinder in rpms.

   The grit size is determined by the opening per running inch in the screens or sieves through which the cutting particles are sieved before being formed into a wheel. Thus, in a 60-grit wheel, each linear inch of the grinding surface has 60 cutting particles, or 3600 per square inch. A 30 to 40-grit wheel (coarse) is used for coarse grinding, such as cast iron, plowshares, and other rough work. A 60-grit wheel (medium) is used for grinding axes and most other tools.

4. There are several types of whetstones, sometimes referred to as oilstones. They include sandstones, Arkansas stones, and carborundum stones, to name a few. There are several varieties of natural sandstone used for redressing tools. One of the most popular is the Ohio blue sandstone. The Arkansas stones are made of a fine-grained rock found near Hot Springs, Arkansas. They are available in three grades: soft, hard, and very hard. The other stone mentioned is made in electric furnaces. They are available in grits from coarse through very fine. Some synthetic stones are also available as two-grit stones, one side being coarse and the other being fine. These stones may be filled with oil or may require that oil or water be added as a coolant to float steel particles from the

stone. Many companies have refined mineral oils designed especially for use with the stones that they sell.

5. Templates or tool-grinding gauges can be made easily out of thin sheet metal and a pair of tin snips. A protractor or any device to give the correct angle (including a tool in good state of repair) can be used to lay off the angle. After the angle is cut out with the tin snips, the template can be used as a quick reference to determine if the correct angle is being placed on the tool. (Transparency III-1-B)

6. Transparency III-1-C shows the parts of a file. The single-cut file is grooved diagonally in one direction only, so that it has chisel-like teeth. Double-cut files are grooved in two directions and have sharp, triangular teeth. They cut faster than, but not as smoothly as, the single-cut file. File teeth usually slant toward the point of the file. Therefore, these files cut only on the forward stroke. Both single-cut and double-cut files are made in different degrees of coarseness, such as rough, middle, bastard, second cut, and smooth. The coarseness of a file also varies with its length. For example, a 6 inch flat bastard file is smoother than a 12 inch flat bastard. Commonly used files are (Transparency III-1-C):

   a. Flat,

   b. Round,

   c. Half-round,

   d. Tapered,

   e. Oval, and

   f. Square.

   When file teeth become clogged with metal chips, filing is slower and results in a rough surface. The best way to clean a file is to rub the file card (Transparency III-1-D) across the file in the same direction as the cut of the teeth until the chips are loosened. If the chips are too tight for the file card to remove, scrape them loose with a nail or a pointed piece of wire. After the chips have been loosened, brush the file clean with a bristle side of the file card. Rub the file with chalk before filing soft metal. Chips are then easily removed with a file card. Oil on a file interferes with the cutting. Remove it by chalking the file and then brushing it clean. Clean the file and brush it dry to remove chips and moisture at the end of each job. Always store files in separate holders to prevent their rubbing together or knocking against other tools. The teeth are brittle and thus are easily dulled or broken if the files are not properly put away.

7. A steel is an instrument that is held upright in the left hand. Holding the edge of the blade at a 20 to 45 degree angle to the surface, bring the blade across the steel with the cutting edge of the blade leading. Repeat the process for the other side of the blade. Usually only a few strokes on both sides are necessary to produce a fine edge. (Transparency III-1-E)

8. Safety practices with tool fitting equipment

   a. Power grinder safety:

      1) While grinding, protect the eyes with goggles or a face shield.

      2) Keep the guard adjusted as near the wheel as possible.

      3) Keep the tool rest adjusted to within 1/8 inch of the grinding wheel at all times.

      4) Keep the grinding wheel true by frequent dressing.

      5) Use only the curved face of the wheel for grinding, not the flat sides.

      6) Do not run a wheel at a higher speed than is recommended by the manufacturer.

7) Tighten the grinder wheels securely to the arbor and the grinder to a table or pedestal.

8) Apply the stock or tool slowly to the grinding wheel.

9) Do not use grinding wheel if it is worn to less than half its original diameter. At this point, it must be replaced.

b. Filing safety:

Since the tang of a file is sharp enough to injure your hand badly if it should slip, always fit the tang into a handle. To tighten the handle, hold the file vertical and tap the end of the handle on the workbench. To use the file, grasp the handle in one hand and hold the file point with the thumb and forefinger of the other hand. Secure the stock firmly, preferably in a vise, to prevent chatter or vibration, which damages the file.

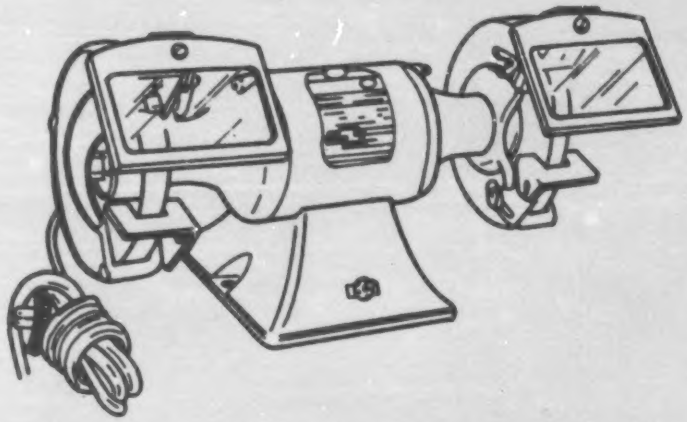
Protect the stock from the vise jaws by clamping it between pieces of wood or soft metal, such as copper or lead.

C. Suggested Student Activities

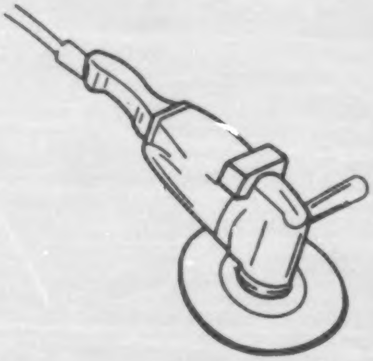
1. Class will evaluate different shop tools to determine if the tools require fitting.

2. Each student will evaluate tools that are in his/her home and give a report as to the number found in need of fitting.

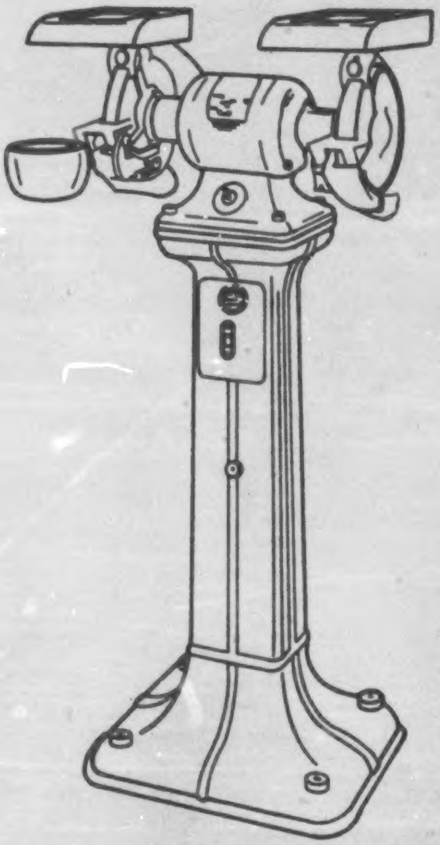
3. Assign students a defective tool that needs fitting. Have students make a report on how they would go about restoring the tool to its proper working condition.



SMALL BENCH GRINDER

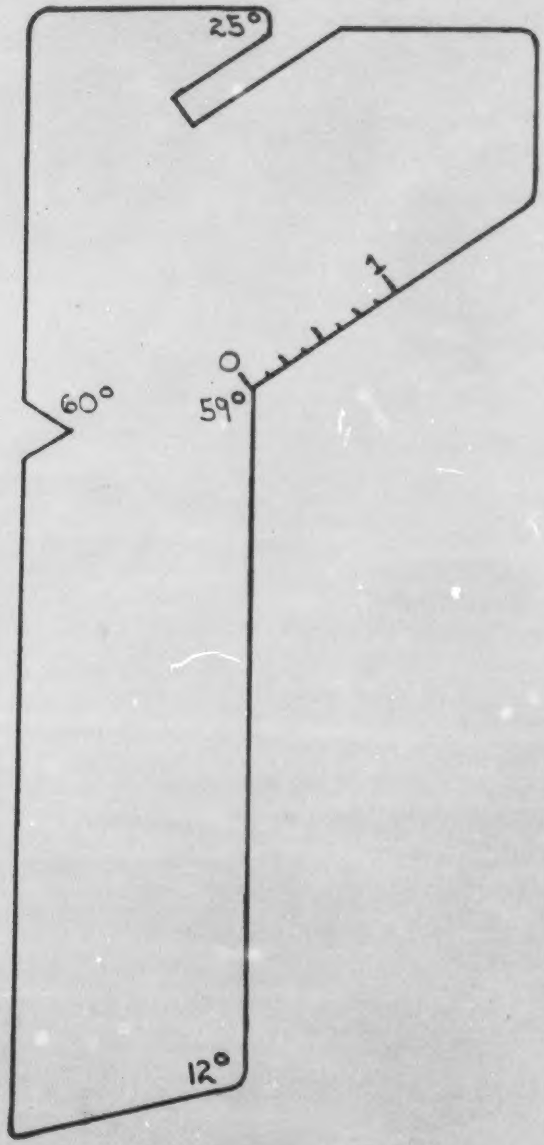


PORTABLE GRINDER



A PEDESTAL GRINDER

TEMPLATE

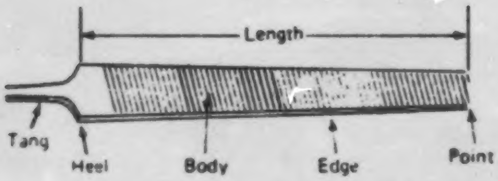


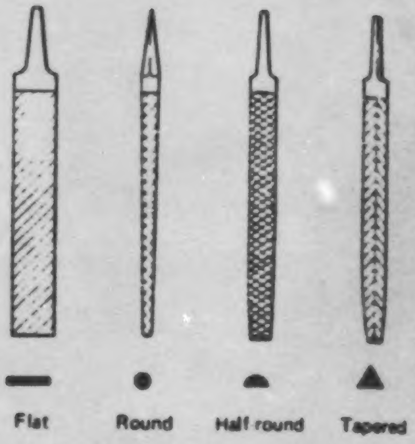
A TEMPLATE OR TOOL GRINDING GAUGE IS

NECESSARY WHEN FITTING CERTAIN SHOP TOOLS.

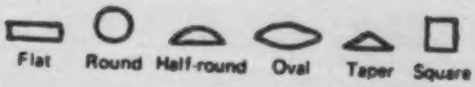
TRANSPARENCY III-1-B

PARTS AND SHAPES OF FILES


Length
Tang
Heel
Body
Edge
Point


Flat
Round
Half round
Tapered

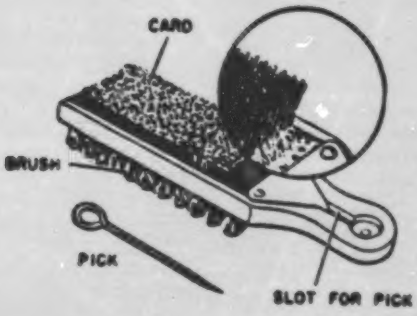
COMMONLY USED FILE IN THE SHOP


Flat
Round
Half-round
Oval
Taper
Square

CROSS-SECTIONAL VIEW OF COMMON FILES

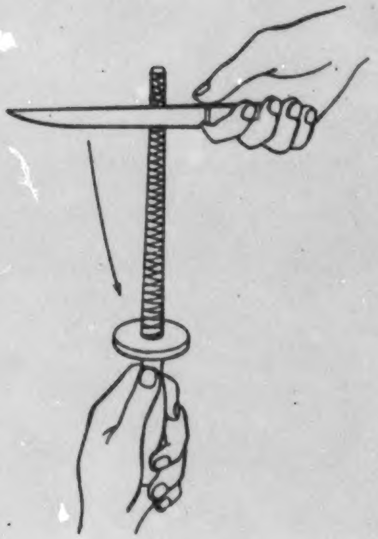
TRANSPARENCY III-1-C

PARTS OF A FILE CARD


CARD
BRUSH
PICK
SLOT FOR PICK

TRANSPARENCY III-1-D

PROCEDURE FOR USING A STEEL TO SHARPEN A KNIFE



TRANSPARENCY III-1-E

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT III: Tool Fitting

LESSON 2: Reshaping a Screwdriver

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Describe the proper procedure for reshaping a screwdriver.

2. Specific:

a. Differentiate among standard, Phillips, clutch head, offset, and spiral ratchet screwdrivers.
b. Define correct procedure for determining thickness of a standard screwdriver bit that needs fitting.
c. Describe the procedure for reshaping a standard screwdriver on a grinding wheel.
d. Name the type of grit needed in "c" above.
e. Name the type of file used to reshape a Phillips screwdriver.
f. Describe the procedure and tool used to reshape a clutch head screwdriver.
g.

h.

i.

B. Review of Teaching Materials

1. Phipps, L.S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

2. McCoy, V.L. and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

1. Obtain different types of screwdrivers that need to be reshaped.
2. Secure the different types of files and/or tools and equipment to be used.

D. Materials required

1. Overhead projector and screen
2. Material mentioned in "1" and "2" above.

II. Presentation of Lesson

A. Motivation

A keen-edged tool is essential for good workmanship. A skilled craftman cannot do his best work with dull, nicked, or improperly sharpened tools; a beginner is under an even greater handicap. Tools are designed and sharpened by their manufacturers to give the maximum amount of service. A person who buys and uses them expects them to do efficient work. Unless, however, he keeps them in proper working condition, he will not obtain satisfaction from their use. If the screwdriver is improperly used to pry things open or off, the blade may bend. If this happens, the bit will not longer be round and in line with the handle. This will cause the tip to slip out of the slot of the screw when the screwdriver is turned. This can lead to damage to the screw slot, resulting in a screw than cannot be removed.

B. Content Outline

1. Terms:

   a. Standard screwdriver -- Has a straight bit with a slotted head.

   b. Phillips screwdriver -- Has a cross-shaped bit with a tapered end.

   c. Clutch-head screwdriver -- Has a bit shaped similar to a figure 8.

   d. Offset screwdriver -- Used when it is impossible to use a standard screwdriver because of the lack of space or a difficult angle.

   e. Spiral ratchet screwdriver -- Sometimes referred to as a "Yankee Drill," this screwdriver is operated by pumping the handle up and down. This pumping action turns the bit. (See Transparency III-2-A)

2. Screwdriver tips become broken, twisted, or worn thin after long use and must be reshaped. A twisted tip may be straightened on the anvil with a hammer. A broken or worn tip can be reshaped on the grinding wheel. Before starting to grind the tip, select a flathead wood screw that has a slot the same length at the bottom as the screwdriver tip is wide. Use the screw slot to gauge the thickness of the screwdriver tip. When the tip has been ground correctly, it should support a wood screw as indicated in Transparency III-2-B. If the tip is broken off completely or worn too short, if should be reshaped and tempered.

3. Use the following procedure for reshaping the screwdriver tip on the grinding wheel:

   a. Place the screwdriver blade flat on the tool rest and push the tip lightly against the grinding wheel to square the tip and remove any gaps. Grind the tip back until it is as thick as, or slightly thicker than, the width of the screw slot. You can grind off any excess metal in step c.

b. Grasp the screwdriver handle in the right hand, and place the tip on the top of the grinding wheel, as indicated in Transparency III-2-C.

c. Apply light pressure on top of the blade with the left hand, and move the tip back and forth the length of the flat surface until it is ground to the proper shape. Since the screwdriver must have a square end on the tip, do not round off the end by pulling the tip back too far. Place the tip in the screw slot frequently during the grinding operation to see if it is being ground to the correct thickness. Transparency III-2-B shows a properly fitted screwdriver tip.

4. A medium-grit grinding stone should be used on the power grinder. Be careful not to overheat the bit, because it is made of high-carbon tool steel and may lose its temper (hardness). Dip the bit into either oil or water to cool it.

5. There is a limit to the number of times a screwdriver can be redressed. When it is no longer possible to restore the bit to its correct width and thickness, the screwdriver should be discarded.

6. To reshape the Phillips screwdriver bit, use a small, three-corner file to square the shoulders of the bit. Take a screw with the Phillips-shaped slot and use it to test the fit of the bit. Do not sharpen the end of the bit to a point.

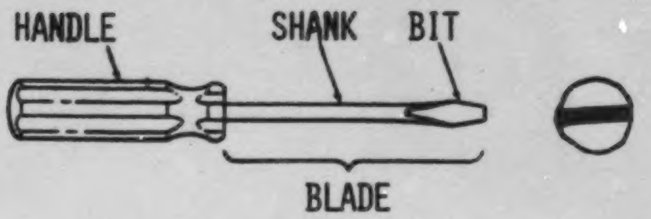
7. To reshape a clutch head screwdriver, use a small round file to restore the bit to its original condition. The end of the bit can be squared with a flat file or the power grinder.

C. Suggested Student Activities

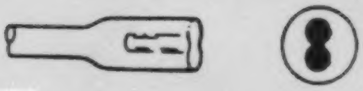
1. Ask each student to bring a screwdriver that needs reshaping.

2. Have each student reshape a screwdriver.

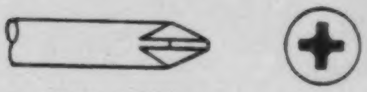
TYPES AND PARTS OF A SCREWDRIVER


HANDLE
SHANK
BIT
BLADE

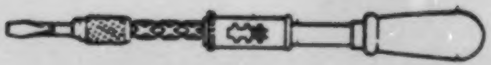
STANDARD



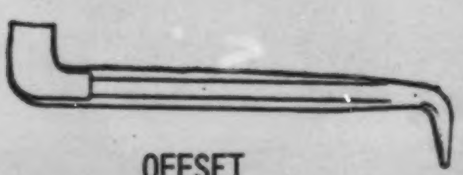
CLUTCH-HEAD



PHILLIPS



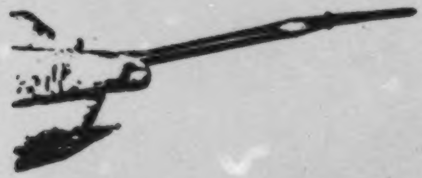
SPIRAL RATCHET



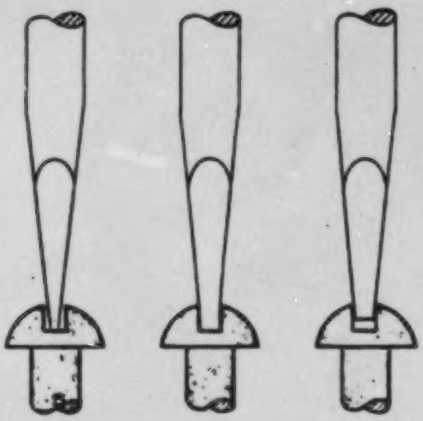
OFFSET

TRANSPARENCY III-2-A

PROPERLY GROUND SCREWDRIVER TIP

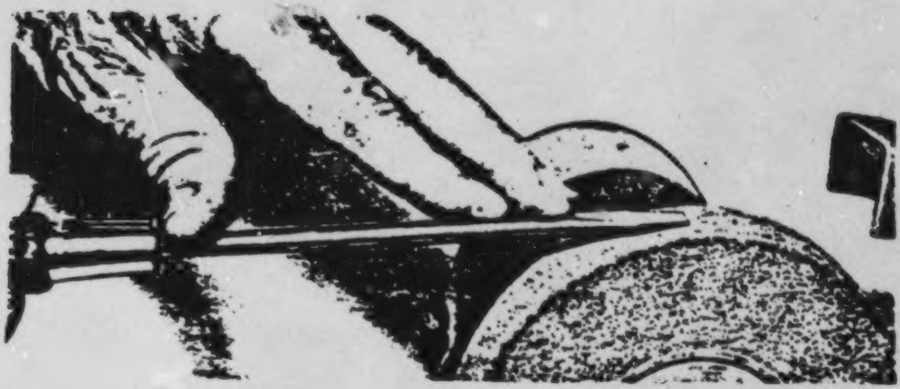


WHEN THE SCREWDRIVER TIP IS GROUND CORRECTLY, IT SHOULD SUPPORT A WOOD SCREW.


TOO THIN
CORRECT
TOO THICK

TEST SHAPE OF SCREWDRIVER TIP

CORRECT METHOD OF USING THE GRINDING WHEEL



HOLD THE SCREWDRIVER TIP AGAINST THE GRINDING WHEEL IN THIS MANNER.

TRANSPARENCY III-2-C

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT III: Tool Fitting

LESSON 3: Sharpening a Wood Chisel

I. Preparation for Instruction

  A. Student Objectives

    1. Terminal: Demonstrate the correct procedure in sharpening a wood chisel.

    2. Specific:

      a. Define and give the purpose of a wood chisel.
      b. Indicate the correct angle of bevel for a wood chisel.
      c. Demonstrate the correct procedure to follow in sharpening a wood chisel.
      d. Discuss why whetting a wood chisel is important.
      e.

      f.

      g.

  B. Review of Teaching Materials

    1. Phipps, L.S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

    2. McCoy, V.L. and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

  C. Special Arrangements

    1. Secure wood chisels with broken or badly nicked cutting edges.

    2. Secure wood chisels with mushroom heads.

D. Materials required

1. Overhead projector and screen.
2. Wood chisels (as described in one and two above)

II. Presentation of Lesson

A. Motivation

The wood chisel is designed to remove wood when struck with a mallet or when pushed by hand. The wood chisel works much like a crude plane. Like the standard screwdriver, it is also quite often abused in most shops.

B. Content Outline

1. If the wood chisel is properly cared for and used correctly, it may be redressed several times with a whetstone before it needs to be ground on a grinding wheel. If the cutting edge is badly nicked, it will be necessary to go directly to the grinding wheel.
   The angle of the edge should be 25 to 30 degrees for most work.

2. Procedure to following in sharpening a wood chisel:

   a. To remove any gaps (nicks), place the wood chisel flat on the tool rest with the beveled side down and move the chisel from left to right until the cutting edge is ground square.

   b. Place the chisel between the left forefinger and thumb and place the forefinger against the outside edge of the tool rest, as shown in Transparency III-3-A. Push the chisel forward between the forefinger and thumb of the left hand until it is at the proper angle with the grinding wheel.

   c. Hold the chisel firmly in the left hand and slide the left forefinger from left to right along the edge of the tool rest for a guide until the entire width of the edge has been ground almost to a wire edge. Use right hand to apply pressure and help guide the chisel. To help keep the cutting edge square with the sides, stop the strokes when the back edge of the chisel passes beyond the edge of the grinding wheel about one-third of the width of the wheel. Check the bevel with the template frequently during the grinding to see that it is being ground to the proper angle.

2. Whetting a wood chisel

   When the grinding is finished, the bevel is hollow ground. This will allow the wood chisel to be sharpened several times by whetting before regrinding is necessary.

In whetting a wood chisel, use the following procedure:

a. Place the wood chisel on an oilstone with the heel and toe on the hollow ground bevel touching the stone, as shown in Transparency III-3-A. Whet the wood chisel straight backward and forward.

b. Turn the chisel over and lay it flat on the surface of the oilstone to prevent beveling. Whet it only enough to remove the wire edge. Repeat the above steps until the cutting edge is practically razor sharp.

3. The head of an all-steel chisel (without a handle) may also require redressing. The head should be square with the shank, and the crown radius should taper away from the head as shown in Transparency III-3-B. Square the head or grind the crown radius to restore it to original condition. However, if the head is badly chipped or "mushroomed," it is better to discard the chisel.

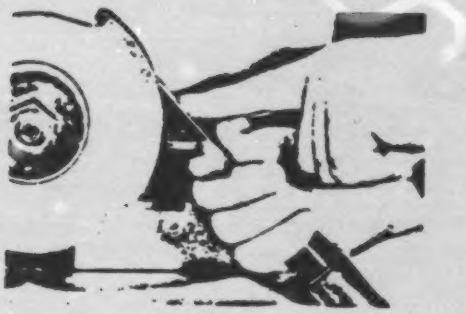
C. Suggested Student Activities

1. Assign each student a project that requires the use of a wood chisel.

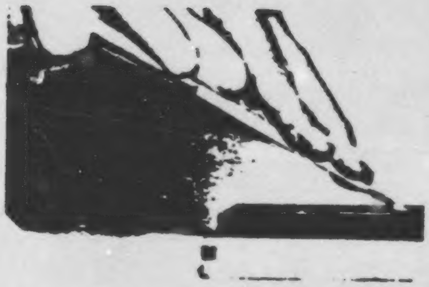
2. Assign students a wood chisel and ask them to demonstrate the correct procedure to whet the chisel.

3. Ask students to find out the price of a common sized wood chisel. Lead the students in a discussion as to which they had rather do...buy a new wood chisel or sharpen one that has been given proper care.

SHARPENING AND WHETTING A WOOD CHISEL



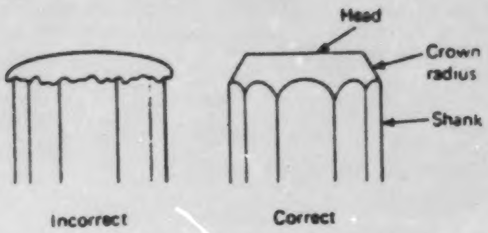
SHARPENING A WOOD CHISEL



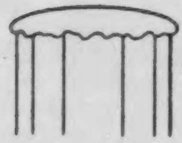
WHETTING THE BEVEL OF WOOD CHISEL

TRANSPARENCY III-3-A

MUSHROOMED HEADED CHISELS


Head
Crown radius
Shank
Incorrect
Correct

REDRESSING THE HEAD OF A WOOD CHISEL.



A COLD CHISEL WITH A MUSHROOMED HEAD. THIS CHISEL IS DANGEROUS TO USE. IT SHOULD BE REDRESSED.

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT III: Tool Fitting

LESSON 4: Sharpening a Mower Blade

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Describe the proper procedure to follow in sharpening a mower blade.

2. Specific:

   a. Name the type of grinding wheel recommended to sharpen a sickle blade.
   b. Explain the importance of maintaining a balanced rotary mower blade.
   c. List the safety rules to be followed in sharpening a mower blade.
   d. Describe the procedure to follow in sharpening knives from a sickle type of blade.
   e. Describe the procedure to follow in sharpening a lawn mower blade.
   f.
   g.
   h.

B. Review of Teaching Materials

1. Phipps, L.S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

2. McCoy, V.L. and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

1. Have on display dull or nicked knife sections of a mower, swather, or combine.

2. Have on display a dull or badly nicked lawn mower blade.

D. Materials required

1. Overhead projector and screen

2. Sickles from a mower blade

3. Blade from a lawn mower

II. Presentation of Lesson

A. Motivation

1. Properly conditioned tools and equipment are necessary to do a good job.

2. The person who has a favorite pocket knife knows that the knife blade will eventually become dull. The longer the knife is used, the duller it gets and the poorer it performs.

3. Cutting tools simply do not perform well when their blades are dull or nicked. They do not do their job properly, and also they require the person using them to work harder and less effectively than is desirable or necessary.

B. Content Outline

1. Recondition mower sickles:

   a. It is rather time consuming to sharpen various knife sections of a mower, swather, or combine sickle. And some people think that, all things considered, the worker is better off simply replacing dull and nicked sections. A cheaper and more economical route may be taken, however. The sections may be sharpened. To sharpen them, it is best to use a special double-beveled grinding wheel (Transparency III-4-A.) This wheel allows one side of the first section to be ground while grinding the opposite of the next section.

   b. Procedure to follow: Hold the back of the sickle (if the sickle is long, help may be needed to hold it for grinding) and position the knife sections so that they make contact with the grinding wheel near the point. Move the sickle back and forth across the face of the wheel to prevent overheating of the sections. Do not grind sections more than necessary to remove nicks and restore the original angles. After doing two sections at a time, move on to another two sections (if all sections need work).

2. Reconditioning rotary mower blades:

   a. Rotary mower blades operate at very high speeds (19,000 ft/min. or 215 mph). Because of the effects of centrifugal force, it is very important that the blade remain balanced.

   b. Procedure to follow: Remove the blade from the mower, noting which side is on top. The bevel should be on top. Using a medium-grit grinding stone, position the blade on the tool rest so that one end of the blade contacts the wheel and the grinding action is toward the blade. Check the original angle (30 to 40 degrees), and try to maintain that angle during the grinding.

To grind, move the blade across the wheel. It is important to count each stroke to make sure both ends of the blade will be in proper balance later. Inspect the blade after each stroke. When the nicks are removed, reverse the blade and grind the opposite end with the same number of strokes. After the grinding is done, it is advisable to check the blade on a balance point.
(Transparency III-4-B)

3. Safety rules:

The following safety rules should be followed in reconditioning a mower blade:

a. Don't use a grinding wheel that has been worn to less than half of its original diameter. When the wheel is worn beyond one-half its diameter, there is a greater danger of its shattering.

b. Always wear protective safety glasses or a face shield. In fact, most state laws require persons using grinding wheels to wear not only safety glasses but also a full-face shield as protection against hot sparks.

c. Be careful in directing the sparks. They should not be directed toward other persons or into materials that may be combustible.

d. Wear long-sleeved garments and leather gloves. This is especially important when you are doing heavy grinding.

e. Never try to grind with the side of the wheel. Such force may cause the wheel to break.

C. Suggested Student Activities

Assign students the task of removing the blade from their home lawn mowers. Have them sharpen their blades in shop as a lab exercise.

DOUBLE BEVELED GRINDING WHEEL

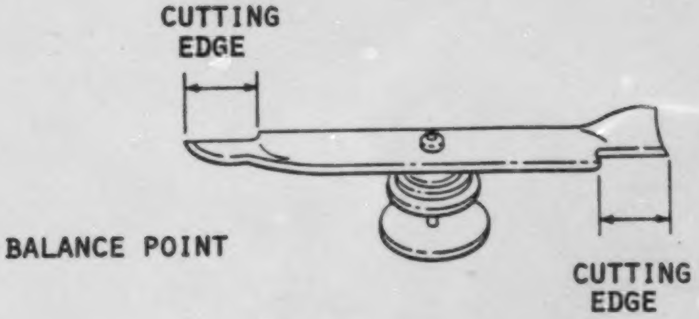
GRINDING WHEEL

TEMPLATE TO CHECK GRINDING WHEEL TO ENSURE THAT IT IS TRUE.

GRINDING A MOWER KNIFE (TOP VIEW)

TRANSPARENCY III-4-A

CHECKING THE BALANCE OF A ROTARY MOWER BLADE


CUTTING EDGE
BALANCE POINT
CUTTING EDGE

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT IV: Electricity

LESSON 1: Electrical Terms, Equipment, Meter Reading, and Computation of Cost of KW Hours

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Describe electrical terms, tools and equipment (associated with electrical wiring applications), calculate how to compute the cost of kilowatt-hours, and demonstrate procedure for reading electric meter.

2. Specific:

   a. Define the following terms:
      1) Electricity
      2) Circuit
      3) Conductor
      4) Insulator
      5) Ampere
      6) Volt
      7) Ohm
      8) Watt
      9) Kilowatt-hour
      10) AC
      11) DC
   b. Describe how electrical energy moves through a circuit.
   c. Name the two basic types of circuits.
   d. Identify types of conductors and insulators.
   e. Explain how electric current is measured.
   f. Explain how electrical pressure is measured.
   g. Explain how resistance to current flow is measured.
   h. Describe Ohm's Law.
   i. Explain how electrical power is measured.

j. Explain how electrical energy is measured.
k. Distinguish between AC and DC currents.
l. Describe the tools used in electrical wiring applications.
m. Differentiate between the two types of electrical meters.
n.

o.

p.

B. Review of Teaching Materials

1. Colvin, Thomas S. *Electrical Wiring: Residential, Utility Buildings and Service Areas*. Athens, Georgia: American Association for Vocational Instructional Materials, 1979.

2. Turner, J. Howard. *Understand Electricity & Electrical Terms*. Athens, Georgia: American Association for Vocational Instructional Materials, 1974.

C. Special Arrangements

Secure the following:

1. Tools and equipment as outlined in the lesson,

2. Wiring boards with series and parallel cirucits,

3. Different types and sizes of electrical conductors,

4. Volt-ohm meter,

5. Watt meter, and

6. Cyclometer and pointer types of electrical meters.

D. Materials required

1. Overhead projector and screen, and

2. Materials as described in "1."

II. Presentation of Lesson

A. Motivation

1. Since electricity is one of our primary forms of energy, it is important that everyone understands how it works.

2. In conserving electrical energy, the knowledge of how to determine the electrical load (what units and how much energy) is very beneficial. How many kilowatt-hours are utilized and how much does each unit cost?

3. Another very important aspect of electrical energy conservation is knowing how to read an electric meter. This is very crucial in determining kilowatt-hours and to check to ensure that the electrical bill is accurately reflecting the same units as the electric meter.

B. Content Outline

1. Terms:

   a. Electricity -- For all practical purposes, electricity can be defined as a type of energy that can be converted to light, heat, or power. Electricity may also be defined as the movement or flow of electrons through a conductor.

   b. Circuit -- The "path" followed by the electrons (current) from the point where they leave the generator (source) until they return to it.

   c. Conductor -- Materials that permit electrons to move readily. Examples of these materials are:

      1) Copper,
      2) Aluminum,
      3) Silver, and
      4) Other metals.

   d. Insulator -- Materials that will neither release their own electrons nor allow other free electrons to pass.

   e. Ampere -- When 6.28 quintillion (6,280,000,000,000,000,000) electrons pass any particular point in a circuit in one second.

   f. Volt -- Unit of electrical pressure--pressure being applied to the electrons.

   g. Ohm -- Unit of electrical resistance.

   h. Watt -- The rate of using electrical energy or the rate of doing electrical work. One watt is equal to one joule per second.

   i. Kilowatt-hour -- 1,000 watts, this is the way that an electrical supplier figures the cost of a customer's electric bill.

   j. AC -- Alternating current, flows first in one direction and then in the other.

   k. DC -- Direct current, flows in one direction.

2. How electrical energy moves through a cirucit:

A circuit is the "path" followed by the electrons (current) from the point where they leave the generator (power source) until they return to it. (Transparency IV-1-A).

Note that the circuit is made up of both a delivery wire and a return wire. The reason both wires are needed is to provide one wire on which electrons leave the generator and one on which they can return. The lamp filament is made of a special smaller wire of a different metal (Transparency IV-1-A). The same number of electrons that travels through the circuit must travel through the lamp filament. Energy required to push the electrons through the filament is converted to heat, causing the lamp to glow.

In making the trip from the generator through the lamp and back to the generator, no electrons are destroyed. They simply give up the energy given them by the generator. The energy is then given off by the lamp in the form of light and heat. The current in a circuit goes through a fuse or circuit breaker to the power source or generator (Transparency IV-1-A.) These are protective devices to prevent too much current from flowing, which can happen if the delivery wire and return wire are accidentally "shorted" or brought together. It will also happen if the delivery wire touches the ground or a path to the ground.

An additional protective device has been introduced recently. It is the "ground fault circuit interrupter" (GFCI) (Transparency IV-1-B). It is more sensitive and quicker acting than a fuse or circuit breaker.

The GFCI is designed to protect a person who accidentally touches a "live" wire in the circuit.

The delivery wire is sometimes called the "hot" wire. The return wire is called the "neutral" wire.

The term "hot" wire is not an officially recognized electrical term. It is especially meaningful, though, to those who have touched a wire and received a shock. A person is shocked because of the voltage difference between the person and the "hot" wire. To receive a shock, the body also has to be in contact with another conductor that completes the electrical circuit, such as a damp floor, a metal pipe that connects to the ground, or the second wire of the electrical circuit. 100

Standing on a dry board or wearing rubber-soled shoes or rubber gloves and touching a "hot" wire with the hand will probably not result in receiving a shock. These materials are electrical insulators and prevent your body from completing the circuit.

There are two basic types of circuits. They are as follows:

a. Series (Transparency IV-1-C), and

b. Parallel (Transparency IV-1-C).

A third type is called series-parallel. It is a combination of the other two.

Series circuits provide for all the current in the circuit to flow through each lamp or appliance. In this type of circuit, if one lamp (filament) burns out (or the switch is turned off), the circuit is broken. Current flow stops and other lamps in the circuit will not light. Very few, if any, circuits of this type are used in the home. An example of such a circuit is the older type of Christmas tree lights.

Parallel circuits provide for dividing the current flow through each lamp or appliance in the circuit. Electrons move through the delivery wire and divide. Some pass through the first lamp and some through the second lamp. Each lamp and appliance is constructed so as to allow only as many electrons to pass through it as it needs.

In parallel circuits, if one lamp burns out, the entire circuit will not be broken. Current continues to flow through the other lamps or appliances in the circuit. Of course, if the switch is turned off, no power goes to any part of the circuit. Most circuits in the home are of this type.

There are four conditions that will break the entire circuit and stop current flow in parallel circuits. They are:

a. Main power switch is off.

b. Switch for the circuit is off.

c. Fuse burned out, or circuit breaker or ground fault circuit interrupter tripped.

d. All lamp filaments burned out.

3. Types of conductors and insulators and how they work:

The nucleus of each atom has as many electrons around it as it has protons in its own body. Some basic understanding of the makeup of the atom is necessary before you can understand electricity.

Atoms contain protons and electrons (Transparency IV-1-D). The center or nucleus of an atom contains one or more protons. Scientists believe that protons cluster together to form the nucleus of an atom. Each proton has a positive (+) charge.

Each electron is negatively (-) charged, causing it to be attracted to the positive (+) proton.

In each neutral atom, the number of electrons and the number of protons are exactly equal. In this manner, the atom is "balanced." For example, a hydrogen atom consists of one proton and one electron.

Another example is copper. An atom of copper has 29 protons in the nucleus and 29 electrons in layers orbiting around its nucleus. The number of electrons in each orbit is as follows: 2, 8, 18, and 1 (Transparency IV-1-E).

Copper is a good conductor of electricity. This is because the electron in the outer layer is not held very tightly to the atom. It is easily jarred loose.

Under normal conditions, the atom stays balanced. But, in certain substances, such as copper, some of the electrons are loosely held. When this is the case, an electron may stray over to another atom. That makes too many electrons in that atom, so one of its electrons is attracted over to the first atom (Transparency IV-1-F).

The two electrons are again balanced. Each has the same number of protons as electrons. It is possible, when enough force is applied, for an atom to lose one or more electrons. When one or more electrons are forced on another atom, that atom has a surplus of electrons. It is then that trouble starts (Transparency IV-1-F).

Such action takes place in clouds during an electrical storm (Transparency IV-1-G). Masses of warm air move upward in strong currents. These may be matched by the downward thrust of cold, moist air. As this happens, atoms in one portion of a cloud lose some of their electrons to atoms in another portion of the cloud.

As this imbalance develops, that portion of the cloud losing electrons becomes charged more and more positively (+). Other portions gaining electrons become charged more and more negatively (-). Finally a point is reached where enough electrical pressure has built up for the electrons to jump the space between the negatively and positively charged areas (Transparency IV- 1-G). This, or course, is called lightning.

In lightning the flow of electrons is uncontrolled. The electron flow is so great that it often causes much damage. The lightning stroke may hit a building or a tree. Livestock or people standing in an open field are sometimes struck by lightning.

The electricity in your home is supplied by the same kind of electron exchange, but the flow is under control. Electrons are made to flow in a controlled manner from a generator through a conductor (wire).

The generator is forced to turn by some outside power such as a water wheel, steam turbine, or engine of some type. Small amounts of energy can be supplied chemically, as by a battery. With this energy, the generator takes free electrons off the atoms in the lower wire and forces them on the atoms in the upper wire (Transparency IV-1-H).

This shortage of electrons on the lower wire causes it to become positively charged (+). Electrons from neighboring atoms are attracted and tend to move in and make up the shortage or neutralize the positive atoms. At the same time, the atoms in the upper wire are loaded with too many electrons. That portion of the wire becomes negatively charged (-).

Too many electrons on one side and too few on the other build up electrical pressure. This pressure forces free electrons to move along the upper wire around the loop to the lower wire to supply the electron shortage. No one electron moves very far, but the number that moves is more than imaginable.

As long as the generator runs, there is a continuous flow of electrons (current). If the generator stops, the flow of electrons stops because the electron shortage is met. All of the atoms become neutral.

The forced movement of electrons in one direction or another is what is commonly known as a "flow of current."

As discussed earlier, there is a difference in the atom family relationships of various substances. Some substances have free electrons, ones that are held rather loosely. Atoms in such substances can be forced to give up electrons and accept others with relative ease.

It is from materials such as these that circuits are made. Since they permit electrons to move readily, they are called conductors. Copper, aluminum, silver, and most other metals are examples of good conductors. A good conductor is generally thought of as any element that has fewer than four electrons in its outer orbital layer.

There are other materials, such as glass, rubber, plastic, porcelain, and paper, whose protons hold tightly to their electrons (Transparency IV-1-I). They will neither release their own electrons nor allow other free electrons to pass. They are known as insulators or non-conductors. An insulator is generally thought of as any element that has four or more electrons in its outer orbital layer.

Insulators play an important part in controlling electricity. Wrapping insulating material around a conductor prevents it from touching another conductor. This keeps current in the proper path. It is not free to pass to other conductors.

Insulating material that covers the conductors which connect lamps and appliances keeps an individual from getting shocked when handling them. They prevent your body from completing the circuit to ground. The insulating material also keeps the delivery and return wires apart, thus preventing a "short" circuit.

4. How electric current is measured

Electrons (as previously illustrated) travel along a conductor in a manner similar to water flowing in a stream. This is called a "current." When 6,280,000,000,000,000,000 (6.28 quintillion) electrons pass any particular point in a circuit in one second, this is called one ampere (Transparency IV-1-J). It may also be referred to as "amperage."

The ampere is the unit of electric current. All these electrons are traveling very fast (186,000 miles each second). A 100-watt lamp requires a current of almost one ampere to make it work properly. 105

To measure this current flow an instrument called an ammeter is utilized (Transparency IV-1-J). Current must actually pass through the meter to get a measure of the current flowing. If no current is flowing, the ammeter reads "0."

In Transparency IV-1-J, note that electrons are moving in all parts of the circuit. None of the electrons is burned up or destroyed. Their job is to carry energy from the generator to wherever the energy is needed and to return it to the generator.

Since the ampere is a measure of current flow, it is important to be able to understand and describe the current-carrying capacity of conductors and other electrical equipment. Ampere rating of most heating and power equipment tells the amount of current needed to operate the equipment properly (Transparency IV-1-L). It is generally shown on the nameplate.

Different parts of the wiring system, such as wall switches, fuse boxes, and fuses are also rated in amperes. These ratings tell the greatest amount of current they will handle safely. If more than that amount of current passes through them for a very long period, they will be damaged from excessive heat. Too much current makes a fuse "blow" or a circuit breaker "trip." Fuses and circuit breakers of the proper size will protect the wiring from over-heating (and possible fires) and warn of overloads.

Nameplates on many items of electrical equipment show their rating in amperes. What size wire to use in installing a special circuit, as for example a clothes dryer or an air conditioner, can be determined from the nameplate found on the piece of equipment.

5. How electrical pressure is measured 106

As explained earlier, electrons have to be forced to move through a conductor and around a circuit. The force or pressure that makes them move in the circuit is supplied by the generator.

The volt is the unit of this electrical pressure, the pressure being applied to the electrons. This is the pressure that makes them move when an appliance starts or a light is turned on. This pressure (generally referred to as voltage) is available in wiring circuits all the time (Transparency IV-1-K), whether the electrical equipment is being utilized or not.

When an appliance that is a heavy user of electrical energy starts, voltage may drop a little (Transparency IV-1-M). The lights may blink or become dim. But if the wiring is of the proper size, the drop will not be enough to affect other equipment.

Circuits used for lighting and small appliances around a home, farm, or business are supplied with 115 to 120 volts. Actual voltage may be a few volts higher or lower. This voltage will serve any equipment that has approximately the same voltage marking stamped on it. For example, a light bulb may have "120 volts" stamped on it.

Large equipment, such as ranges and ½-horsepower motors or larger, is designed for use with 240 volts. In fact, many ranges use both 120 and 240 volts to help supply the different heats needed for surface cooking. Note that the range nameplate shown on Transparency IV-1-L indicates "Volts 120-240."

Some motors are designed so they can be connected for use with 120 volts, or they can be reconnected for use with 240 volts, but not both at the same time. Transparency IV-1-L shows how dual-voltage motors are stamped. With this, it can be seen how important it is to understand the meanings of the electrical terms on the nameplates of electrical equipment.

Some equipment that operates on one voltage will show a high and low voltage on the nameplate, such as "100-120." This means that any voltage between these two figures should be satisfactory for operating that piece of equipment.

When your equipment does not work satisfactorily, a voltage check by your power supplier may show that the circuit voltage is much below the voltage shown on the nameplate. If so, heating equipment may heat slowly, lamp bulbs give less light, and motors fail to start readily and develop full power.

On the range nameplate is the term "3W." This also relates to voltage. It tells what the range must be supplied with a 3-wire circuit.

It is from a 3-wire service, supplying 120 and 240 volts, that both of the voltages needed for a range are supplied. One way to find out if there is a 3-wire service to a house is by checking the number of wires that come from the power pole to the meter or from the meter pole to the house.

If there are three wires, both 120 and 240 voltages are available for use.
If the wires are wrapped together, simply count the wires entering the weatherhead.

6. How resistance to current flow is measured

Even when the electrical current flows in a good conductor, some energy is required to force electrons from one atom to the next one. The ohm is the unit of electrical resistance.

There are three factors which determine the amount of resistance (ohms) in a conductor. One is the material of which it is made. Copper and aluminum are commonly used conductors. Another factor is the size (diameter) of the conductor. The larger of two conductors will offer less resistance to flow of electrons. The third factor is the length of the conductor. It is quite logical that electrons traveling the shorter distance would meet less total resistance. Resistance in conductors always generates some heat when current flows through the conductor.

Resistance in conductors (wires) is a problem that has to be considered in supplying electricity to various outlets in a home and in other buildings. The more current the wires carry and the farther they carry it, the larger the wire size should be. Larger wires offer less loss of energy in the form of heat when current is flowing in the wire.

Some substances are neither conductors nor good insulators. They hold their own free electrons rather tightly so they offer greater resistance to current flow. This results in much heat being given off. An example of such a material is the nichrome wire used in making heating elements in electric ranges, toasters and room heaters. Of course, heat used in this manner is for a useful purpose. Heat given off by conductors in a wiring system, however, is a complete loss.

Resistance in electrical wires and equipment can be measured with an ohmmeter and it can be calculated also.

7. How amperes, volts, and ohms relate to each other

As stated earlier in the lesson, a flow of electrons, or current, is measured in amperes. This is frequently abbreviated "amp" or "amps." Also, electrical pressure is required to cause this flow. This pressure is measured in volts. Similarly, there is always resistance to this flow, and the unit of the resistance in the ohm.

The relationship between these electrical terms can be expressed very simply. For example: "One ampere will flow when pushed by one volt against one ohm resistance."

This is called "Ohm's Law." It is one of the basic laws of electricity. It can also be expressed as an equation:

$$\text{Amps} = \frac{\text{Volts}}{\text{Ohms}}$$

Just like all equations, it can be turned around to read:

$$\text{Volts} = \text{Amps} \times \text{Ohms, or}$$

$$\text{Ohms} = \frac{\text{Volts}}{\text{Amps}}$$

So, if two of the values are known, the third value can be computed with this formula. (Transparency IV-1-N)

8. How electric power is measured

Electrical power is measured in terms of watts. It may also be referred to as "wattage." "Amperes" is current flow and "volts" is electrical pressure.

But amps and volts have to be worked as a team when talking about power. Neither term by itself gives a measure of power for turning motors or for developing heat or light.

For example, if 15,000 volts are available but there are no free electrons to flow, there can be no power. Or, if there are enough free electrons in a circuit to provide a flow of 3,000 amperes, there will be no power unless there is voltage to make them flow. But if 15,000 volts and 3,000 amperes are combined, there is enough power for a small city.

In order to get a unit of measurement that shows what volts and amperes amount to in terms of power, simply multiply the two together. Thus,

Volts X Amperes = Watts or
(Pressure) X (Current flow) = (Power)

To show how this works, suppose there is a 120-volt circuit in which 1 ampere is flowing. Multiplying,

120 volts X 1 ampere = 120 watts.

Now suppose there is another circuit with 240-volts and a current flow of 1 ampere (Transparency IV-1-P); multiply

240 volts X 1 ampere = 240 watts.

In other words, by doubling the voltage the watts (power) have been doubled with the same amperage flowing in the circuit.

Voltage is important with equipment that is considered a heavy load because 240 volts require only half as large a wire (diameter) as 120 volts to deliver the same amount of power.

Many items of electrical equipment are rated in watts. One exception is electric motors. Most motors are rated in "horsepower."

Horsepower can be changed to watts rather easily by figuring 1,000 watts for each horsepower of motor rating if the motor is ½ horsepower (hp) or larger. For motors less than ½ hp use 1,200 watts per hp. A 5-hp motor will figure about 5,000 watts at full load. A ¼ hp motor will figure about 300 watts if it is pulling a full load.

A theoretical horsepower is 746 watts, but this does not include loss of energy in the motor through heat and friction. One thousand and 1,200 watts per horsepower are rule-of-thumb figures used for estimating.

If motors are not fully loaded, they do not develop full rated hp. Wattage is less. If they are overloaded for a short period of time, they will develop more than their hp. Then their wattage is more.

As an example of how these terms work together, suppose there is a situation like this: A room heater blows a fuse after it has been used a few minutes.

The nameplate on the heater shows "Watts 1,650, Volts 120."

Suppose the heater on one of the circuits has a 15-ampere fuse protecting it. Is the heater too much load for the circuit? This is a rather common type of experience.

To determine if the load is too heavy for the circuit, divide watts by volts to get amperes. Thus,

1,650 divided by 120 = 13.75 amperes.

This much amperage (13.75 amps) is very close to the full capacity of the fuse (15 amps). Suppose a percolator is added that has a capacity of 350 watts. Then the total wattage is figured as follows:

350 divided by 120 = 2.91 amperes

13.75 + 2.91 = 16.66 amperes

This overloads the circuit, causing the fuse to blow or the circuit breaker to trip.

Equipment of more than 1,000 watts is often rated in kilowatts. A kilowatt is 1,000 watts. The heater we just discussed could have been rated "KW 1.65, Volts 120" which would be the same as the rating given, "Watts 1,650, Volts 120."

A heater with that much wattage should be on its own special circuit.

Present-day general purpose and appliance circuits are of 12-gauge wire which should be protected with a 20-ampere fuse. However, some homes may be wired with the next smaller size wire (14-gauge) for general-use circuits. With 14-gauge wire, 15-ampere fuses are used.

Watts can be measured with an instrument called a wattmeter.

9. How electric energy is measured

What does it cost to operate? This is a question frequently asked, especially when new equipment is being purchased. It is an important question, one that can usually be answered if the individual understands about wattage and how electrical energy is measured.

It is customary to buy goods by measure (gallons or liters), or by weight (pounds or kilograms). For example, gasoline is purchased by the gallon, and grease by the pound (Transparency IV-1-O).

Electrical energy is bought by kilowatt-hours (1,000 watt-hours) (Transparency IV-1-O).

In the discussion, "How Electric Power Is Measured," it was explained that a watt is the rate of using electrical energy or the rate of doing electrical work. For example, when one ampere is pushed through a circuit by 120 volts, the power is 120 watts. This is about the power required to turn a small food mixer.

But "watts" and "horsepower" do not give a measure of the amount of electrical energy a piece of equipment will use. Another unit which includes the time the equipment is "on" is needed.

This unit is the watt-hour (or whr). It combines the watt (unit of power) with the hour (time). It is a relatively small unit. A block of 1,000 of them is more commonly used. One thousand watt-hours equal one Kilowatt-hour (kwhr). "Kilo" means "1,000." This is the unit of electrical energy the consumer uses and pays for each month.

Suppose a man is hired to mow a lawn. The man might be rated as "1 manpower," but is paid only for the hours that the man actually works. Then it can be said that the man is paid by the hour, or manpower-hour.

Electrical energy is paid for in the same way. For example, assume a 1-horsepower motor is fully loaded and operated for 10 hours. Multiplying 1,000 watts (approximately equal to 1 horsepower) by 10 hours, yields 10,000 watt-hours or 10 kwhrs. Watt-hours are such small units of electrical energy that power suppliers sell them to the consumer by the thousand. To get the kilowatt-hours of electrical energy, divide the number of watt-hours by 1,000.

Using a 100-watt light bulb for 5 hours, is figured the same way.

100 watts X 5 hours = 500 watt-hours
500 watt-hours divided by 1,000 = .5 or ½ kilowatt-hour.

Figure power for a food mixer in the same way (but it should be noted that a mixer is used only a few minutes at a time). Suppose it is used for only 15 minutes (¼ hour).

Figure the energy used as shown:
(120 watt requirement)

15 Minutes = ¼ hour
120 watts X ¼ = 30 watt-hours
30 watt-hours divided by 1,000 = .030 kilowatt-hours

10. Types of electric current

Thus far, current has been shown as flowing in only one direction in a circuit. This is called direct current. On most nameplates, it is abbreviated as "DC."

DC is the type of current used in flashlights, portable radios, and automobiles. When electricity was first made available, it was all direct current. There are now few, if any, places where it is still used. DC was found to have a serious disadvantage--it was difficult to deliver over long distances.

The current which flows through lights, refrigerators, and other equipment in your home, flows first in one direction and then the other. It is called alternating current (AC). This flow in one direction, reversing, and getting ready to start all over again is called a "cycle." In most places, 60 of these cycles occur each second. Thus, we get the term 60-cycle AC.

A newer term for "cycles per second" is "Hertz" or "Hz." 114

Most power suppliers control the power to exactly 60 Hertz. Because of this control, an electric clocks keep accurate time. If there should be more cycles per second, the clock would "gain" time; if fewer, the clock would "lose" time.

Most equipment for the home is designed for AC current only. But there are a few items of equipment that will operate on either AC or DC. Examples of these are standard lamp bulbs and portable electric drills.

Connect an ammeter, voltmeter, or wattmeter to an alternating current circuit the same way as for direct current. However, be sure to check the nameplate to see that the meter is designed for use with AC current.

11. Selecting tools and equipment

The basic tools needed by the electrician are as follows (Transparency IV-1-P):

Screwdrivers:

Common and Phillips in several sizes.

Pliers:

Pliers of various types probably rank first among tools frequently used by electricians. Lineman's pliers are available in several sizes with 18 cm and 20 cm (7" and 8") sizes being most popular. The flat jaws will bend, grip, pull, and twist light and heavy cable and wires. The side cutting jaws will cut cable up to large sizes, and the shoulders will crush insulation to make cutting easier. Locking pliers are used to grip and hold cable, tighten connectors, and pull cable. Diagonal cutters have exposed tapered jaws that are convenient for cutting cable ends in boxes and other places where close fitting connections are made. Long nose pliers (often called needle nose) are useful for bending loops in wire to fit under screws. Water pump (channel locking) pliers are used to tighten locknuts and cable connectors.

All pliers should have insulated handles. Slip-on insulated covers are available for most sizes.

Wire stripper:

This tool quickly removes insulation without damage to the wire. Some types include wire cutting jaws.

Wrenches:

Adjustable jaw come in several sizes, 20 cm and 25 cm (8" and 10") are preferred by many. Pipe wrench is used to grip and turn conduit.

Drilling tools:

Portable electric drills and carpenters brace and bits are used to drill holes. Several sizes and types of bits many be used. Hole-saw bits many be used to make larger holes. Various types of auger bits are used for drilling holes in framing. Carbide-tipped bits are required to drill into masonry. Also, star masonry hand bits are often used.

Measuring tools:

Folding extension rules may be made of wood or plastic and are usually six or eight feet in length. The six-inch extension slides out to measure box set-out. Metal tapes with spring return are 1.8 to 6.1m (6 to 20 feet) in length. Fifteen-meter or 30-meter (50-foot and 100-foot) tapes may be metal or fabric and usually have a crank return. The combination square is useful for simple squaring.

Level:

These come in many sizes. They are useful for horizontal leveling or for vertical plumb positioning.

Cutting tools:

The cable ripper will quickly slit the sheath (outer jacket) on cable. A heavy duty pocket knife many also be used to slit sheath and may be used to taper insulation on wire ends. The standard carpenters crosscut saw is for sawing wood. The compass saw or keyhole saw is a small tapered saw for rough cutting holes in flooring, paneling, and plasterboard. The hacksaw is used for metal cutting, including large cable or conductors. Wood chisels are used to cut or gouge wood. The electric saber saw is very versatile. It may be used for cutting wood, metal, and plasterboard.

Electrician's hammer:

The hammer is used for nailing boxes and other devices in place and for driving staples.

Soldering iron:

Soldered connections are not now required in most localities but may be called for under some conditions. Soldered connections are not allowed for certain connections.

Tool pouch:

Use a belt-mounted leather pouch with space to carry "most-used" tools.

Fish tape:

The fish tape is used to pull or push wire through conduit.

Volt-ohm meter:

The volt-ohm meter is used to test circuits for voltage and continuity.

Key to Transparency IV-1-S

1. Portable saber saw
2. Wood chisel
3. Fish tape
4. Volt-ohm meter
5. Pocket knife
6. Cable ripper
7. Hand saw
8. Compass saw
9. Hack saw
10. Carpenter's hammer (claw)
11. Soldering iron
12. Electrician's tool pouch
13. Adjustable jaw wrench
14. Pipe wrench
15. Electrical drill
16. Hole saw bit
17. Star masonry bit
18. Wood bit
19. Folding rule
20. Retractable tape measure
21. Level
22. Plumb bob
23. Flat blade screwdriver
24. Phillips screwdriver
25. Lineman's pliers
26. Locking pliers
27. Cable cutters (diagonals)
28. Long-nose pliers (needle-nose)
29. Channel lock pliers
30. Wire stripper

12. Reading the meter:

There are basically two different types of meters (Transparency IV-1-Q):

a. Cyclometer type, and
b. Pointer type.

Both types of meters have a flat aluminum disk with a black mark along it edge. This disk turns when energy is being used. Meters also have a meter constant. The constant is shown on the meter nameplate in Transparency IV-1-Q. A constant of "Kh = 1.5" means that for each revolution of the disk, 1.5 kwhr has been used.

The cyclometer type of meter is read exactly as the mileage odometer on the family car.

This type is commonly used by power distributors who depend on their users to read their own meters.

The pointer type of meter is a little more difficult to read. Reading this type of meter requires more skill since the pointer on any one dial rotates in the opposite direction to the one next to it. The direction in which each pointer moves must be denoted before one can tell what number to record. The steps in reading a pointer type of meter are:

a. Read the number nearest pointer on right hand dial and record (Using our example this would be a 5),

b. Read the last number passed on the second dial and record on the left of the first number-45,

c. Read the last number passed on the third dial and record-245, and

d. Read the last number passed on the fourth dial and record-3245.

To determine how many kilowatt-hours have been used since the last check period time, simply subtract the old meter reading from the current meter reading. (Transparency IV-1-R)

C. Suggested Student Activities

1. Have the students design simple AC and DC circuits. Assign each student to check the following:

   a. Voltage,

   b. Current (amps),

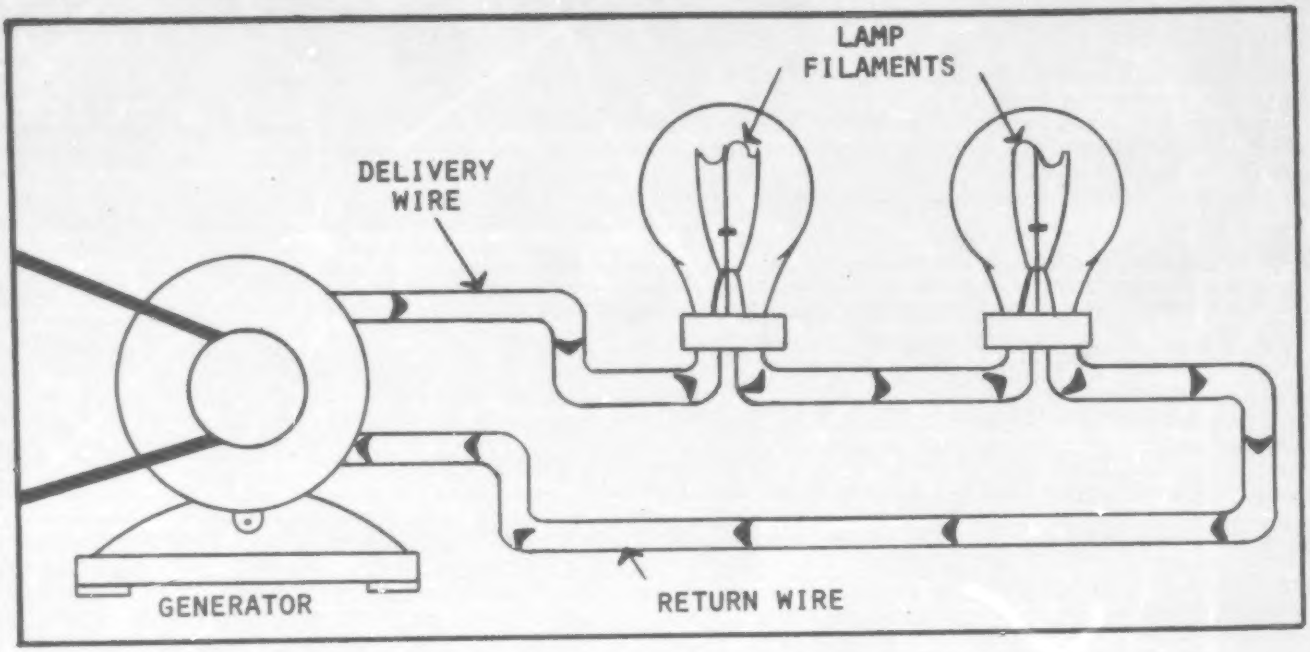
   c. Resistance (ohms), and

   d. Watts.

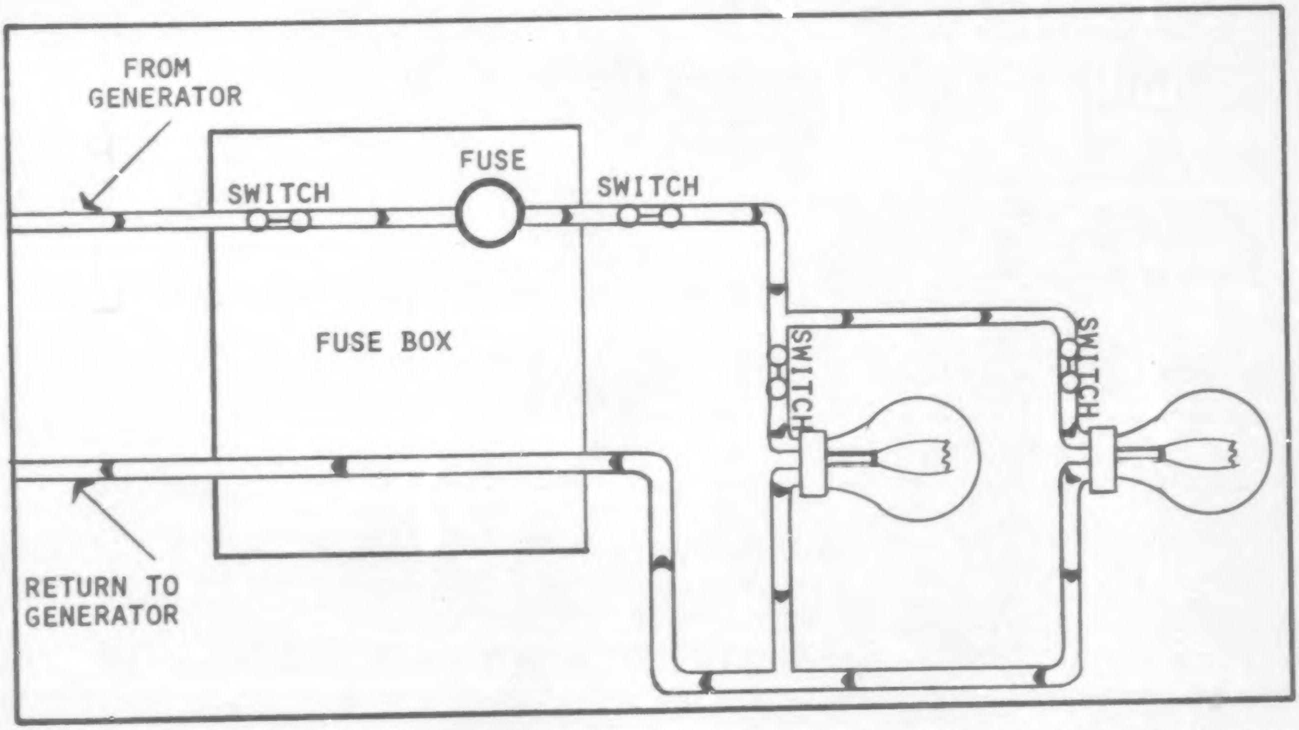
2. Assign electrical problems to students by giving them any two units in Ohm's Law and have them solve for the third. Example:

   An electric toaster draws 3 amps and is on a 120 volt circuit. What is the resistance of the toaster? Solution:

$$R = \frac{\text{Volts}}{\text{Amps}} \qquad R = \frac{120}{3} \qquad R = 40 \text{ ohms}$$


LAMP
FILAMENTS
DELIVERY
WIRE
GENERATOR
RETURN WIRE

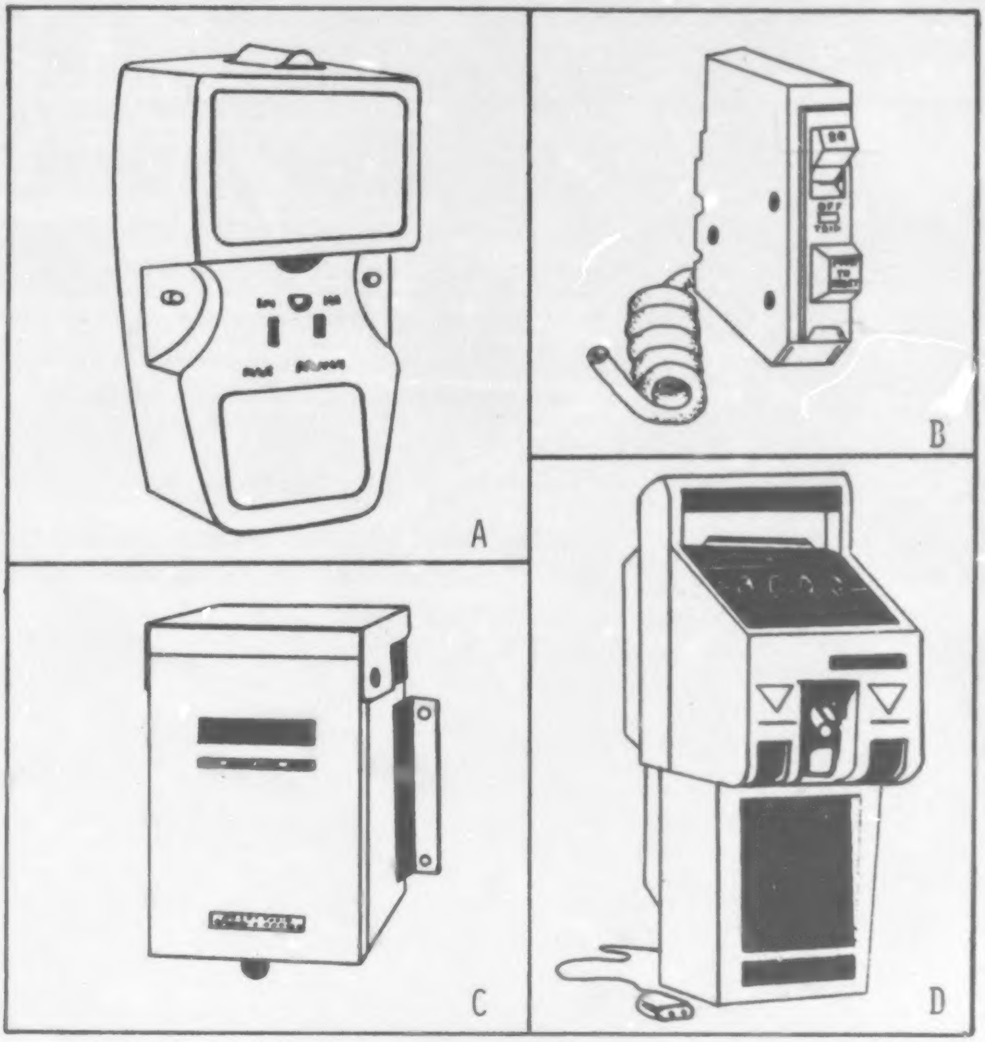
A SIMPLE CIRCUIT


FROM
GENERATOR
SWITCH
FUSE
SWITCH
FUSE BOX
SWITCH
SWITCH
RETURN TO
GENERATOR

A CIRCUIT STARTS AND RETURNS TO A FUSE BOX. IT USUALLY SUPPLIES POWER TO SEVERAL POWER-USE OUTLETS.

TRANSPARENCY IV-1-A

GROUND FAULT CIRCUIT INTERRUPTERS



A PERMANENTLY INSTALLED

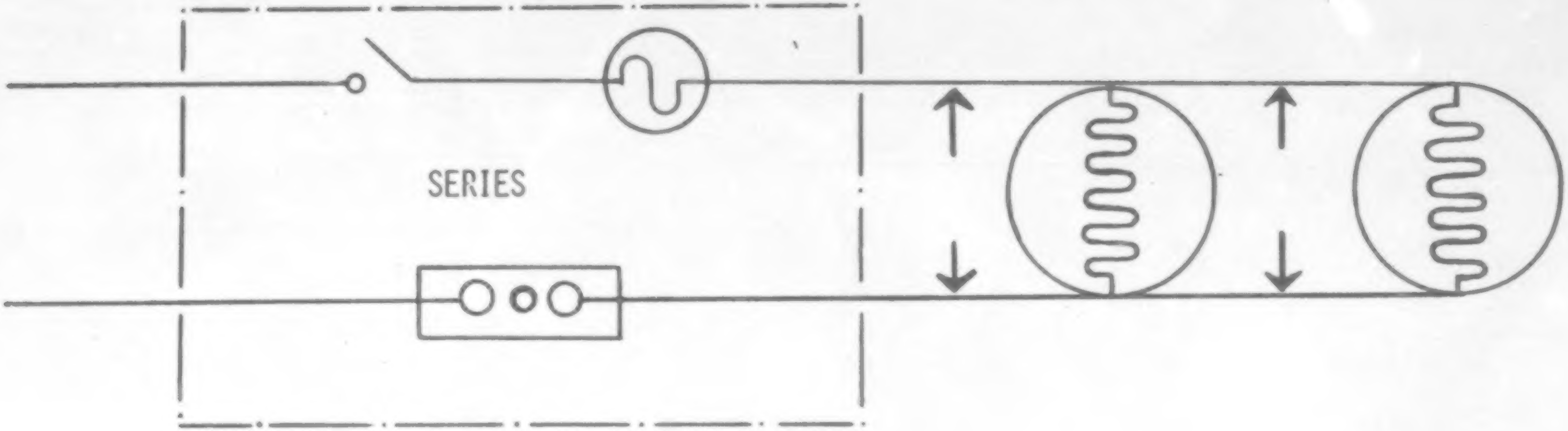
B COMBINATION CIRCUIT BREAKER - GFCI

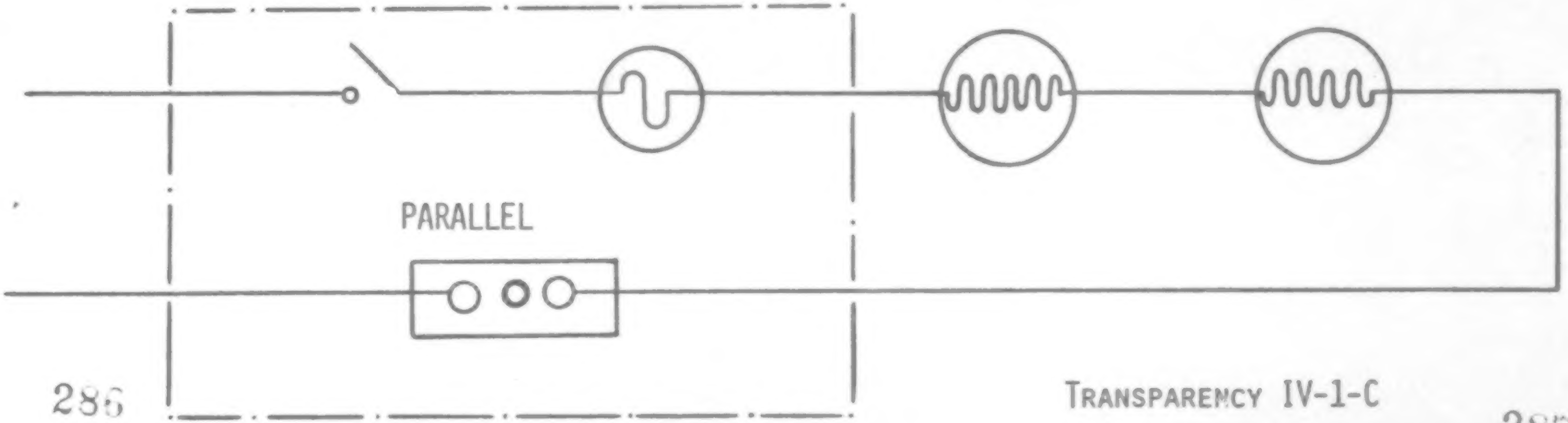
C WEATHERPROOF

D PORTABLE

TRANSPARENCY IV-1-B

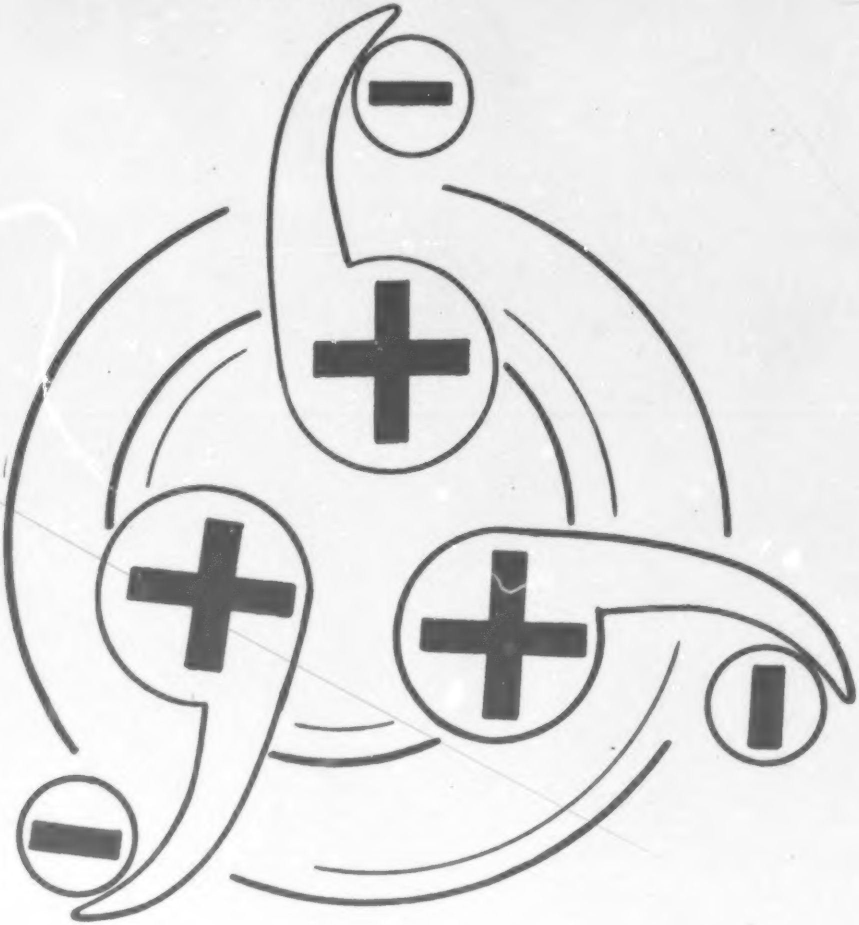
TYPES OF CIRCUITS





TRANSPARENCY IV-1-C

A NEUTRAL ATOM

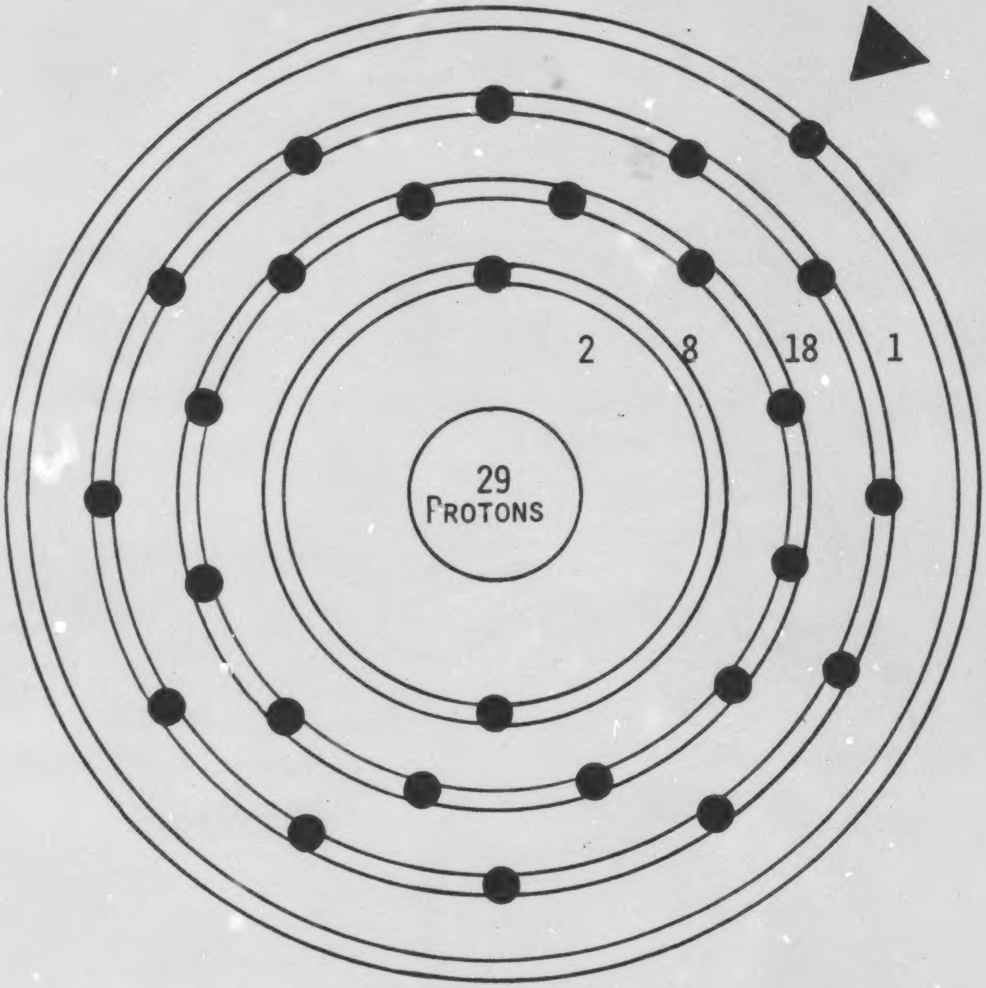


+ = Protons

- = Electrons

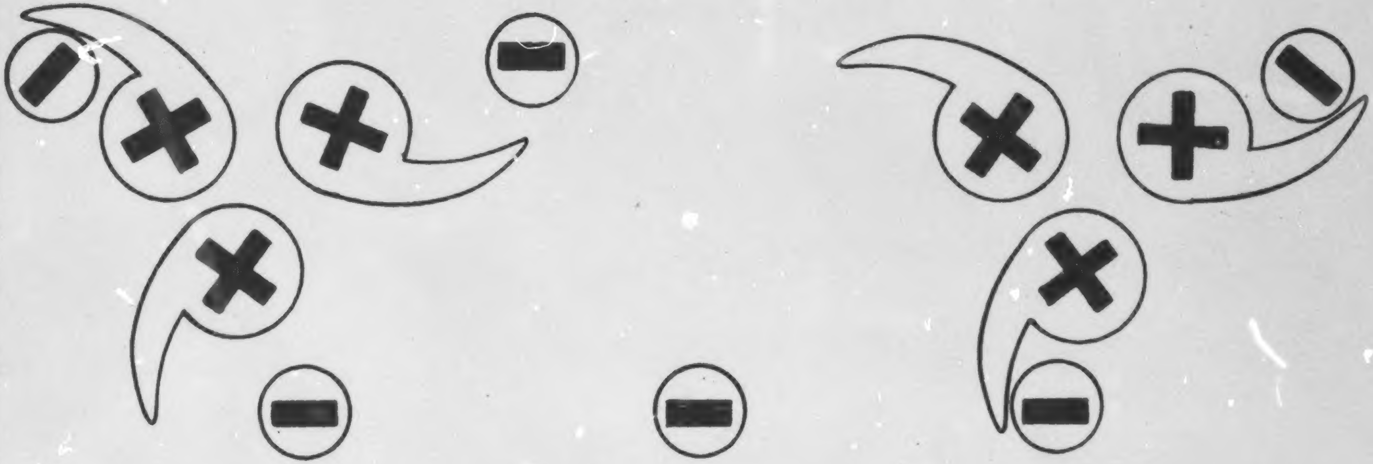
Transparency IV-1-D

THE COPPER ATOM


2
8
18
1
29
PROTONS

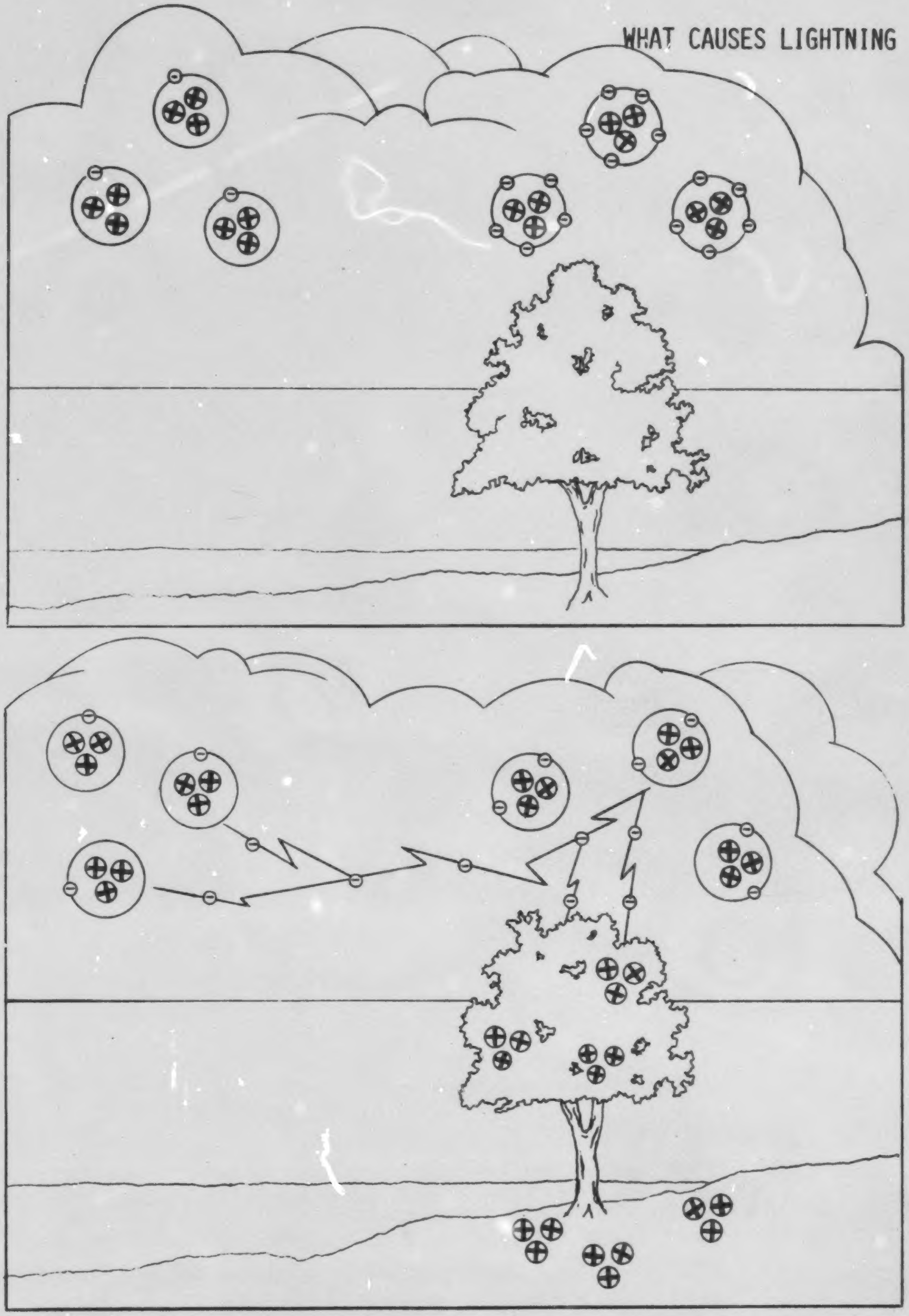
TRANSPARENCY IV-1-E

ATOMS EXCHANGING ELECTRONS



TRANSPARENCY IV-1-F

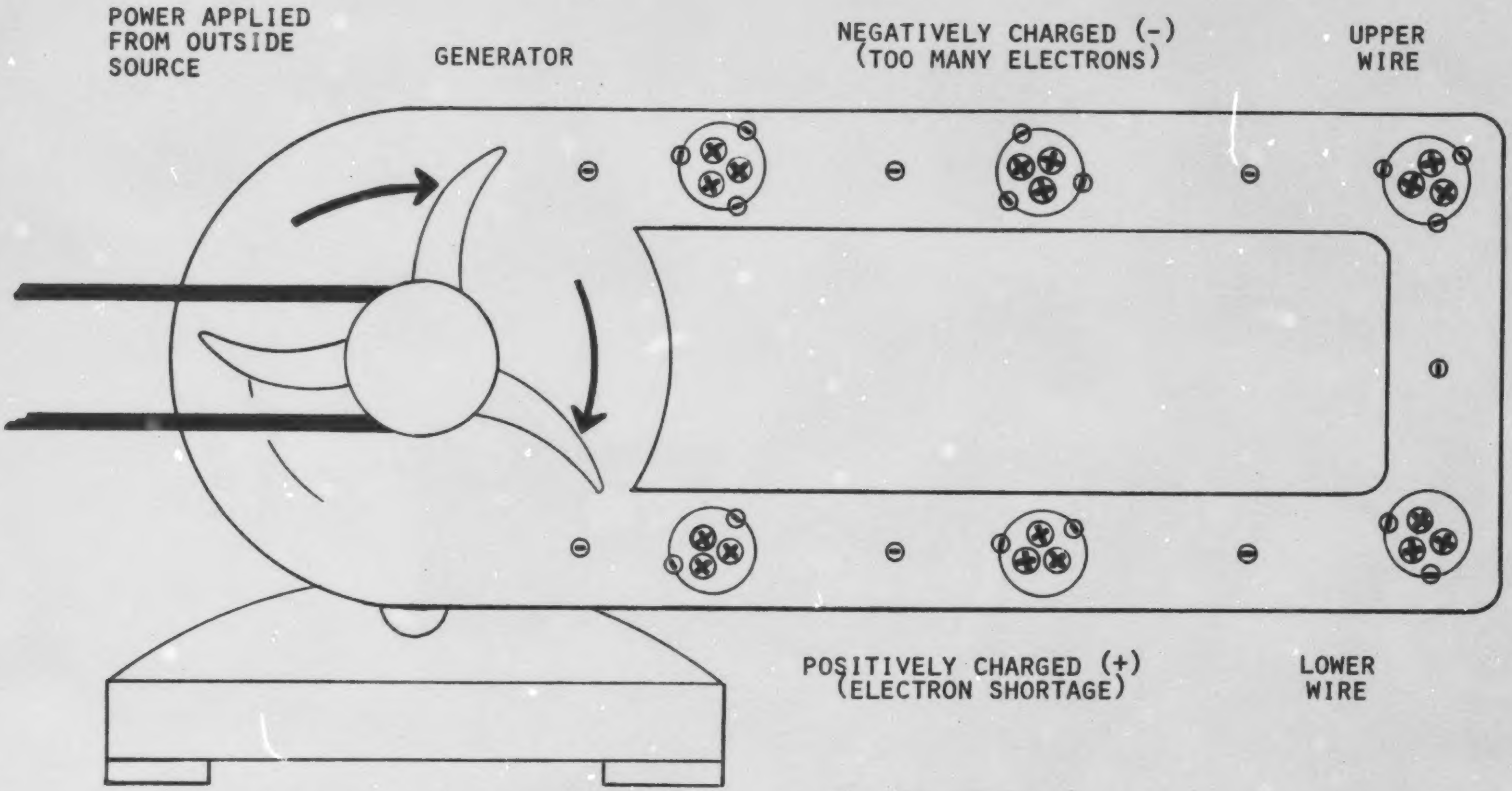
WHAT CAUSES LIGHTNING



LIGHTNING DEVELOPS WHEN EXCESS ELECTRONS PASS FROM THE NEGATIVE CLOUD TO THE POSITIVE CLOUD. THIS CHARGE MAY ALSO PASS THROUGH A TREE OR A TALL OBJECT TO GROUND.

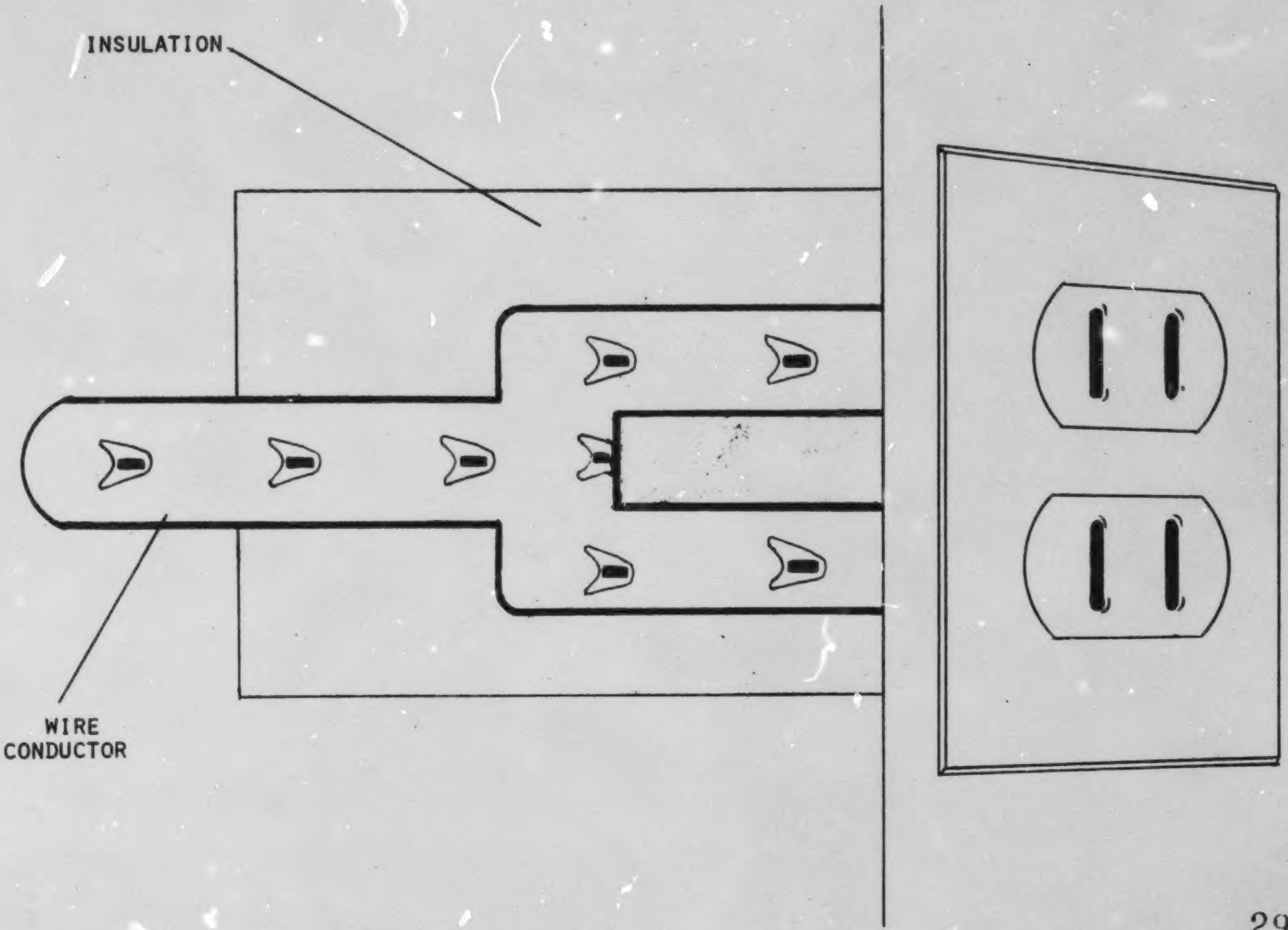
TRANSPARENCY IV-1-G

SIMPLE GENERATOR


POWER APPLIED
FROM OUTSIDE
SOURCE
GENERATOR
NEGATIVELY CHARGED (-)
(TOO MANY ELECTRONS)
UPPER
WIRE
POSITIVELY CHARGED (+)
(ELECTRON SHORTAGE)
LOWER
WIRE

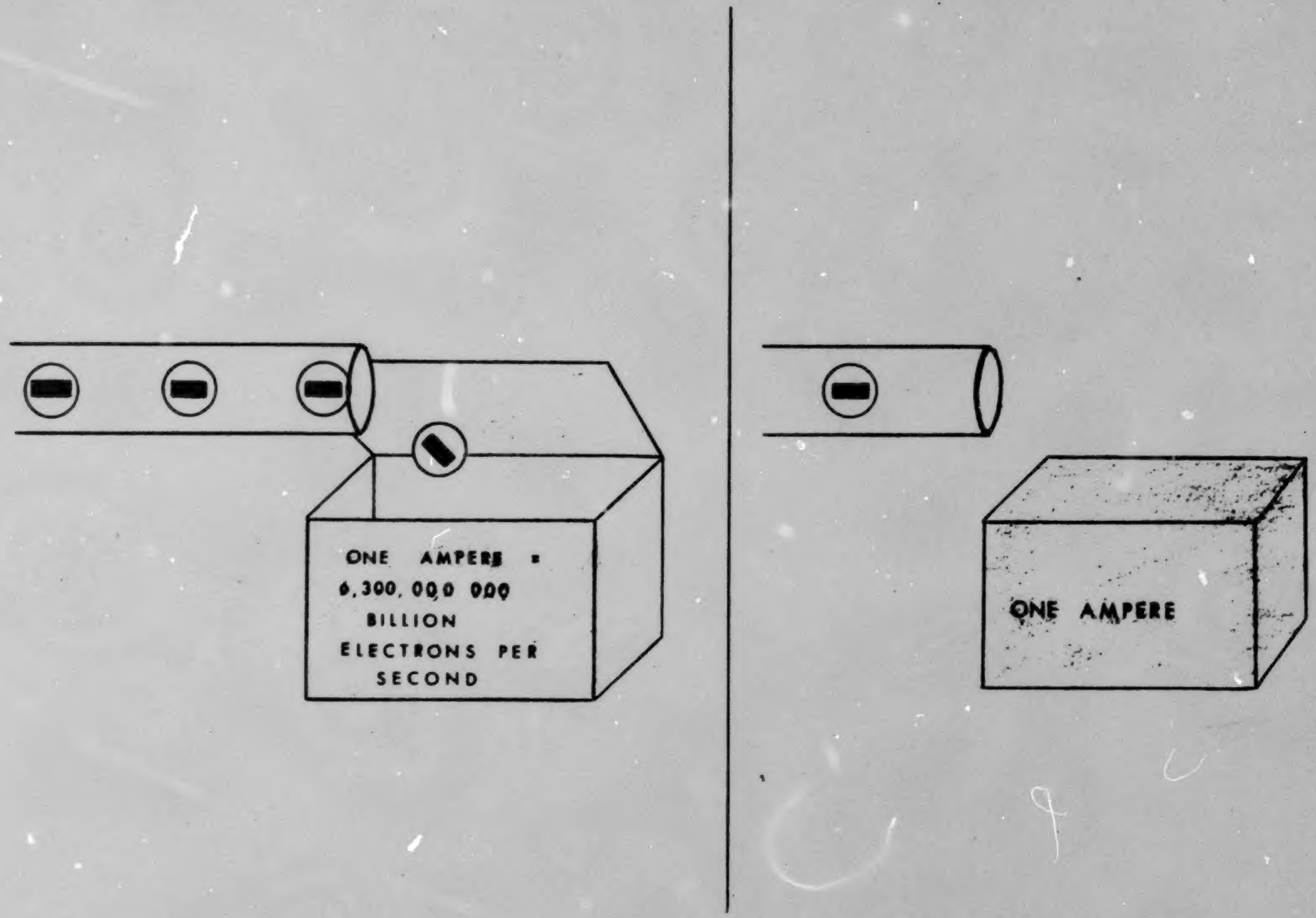
TRANSPARENCY IV-1-H

CONDUCTORS AND INSULATORS


INSULATION
WIRE CONDUCTOR

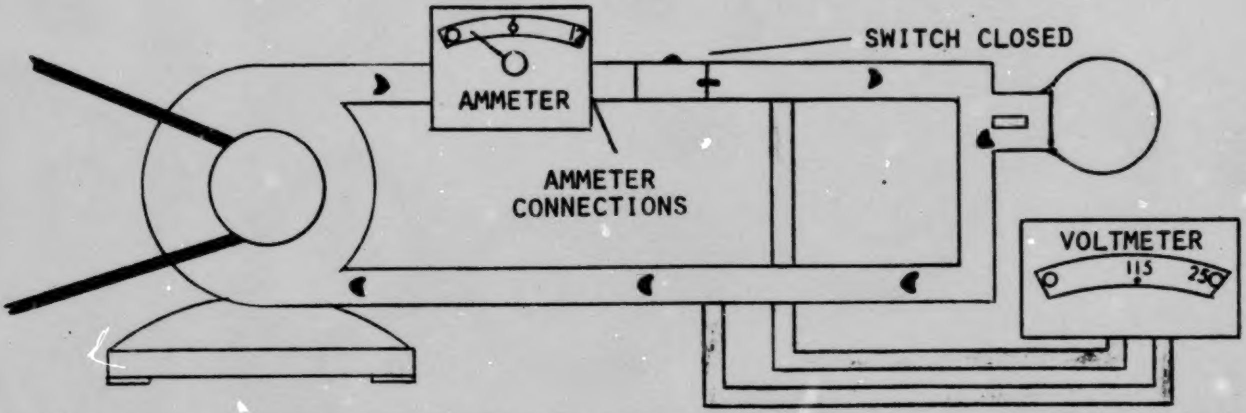
TRANSPARENCY IV-1-I

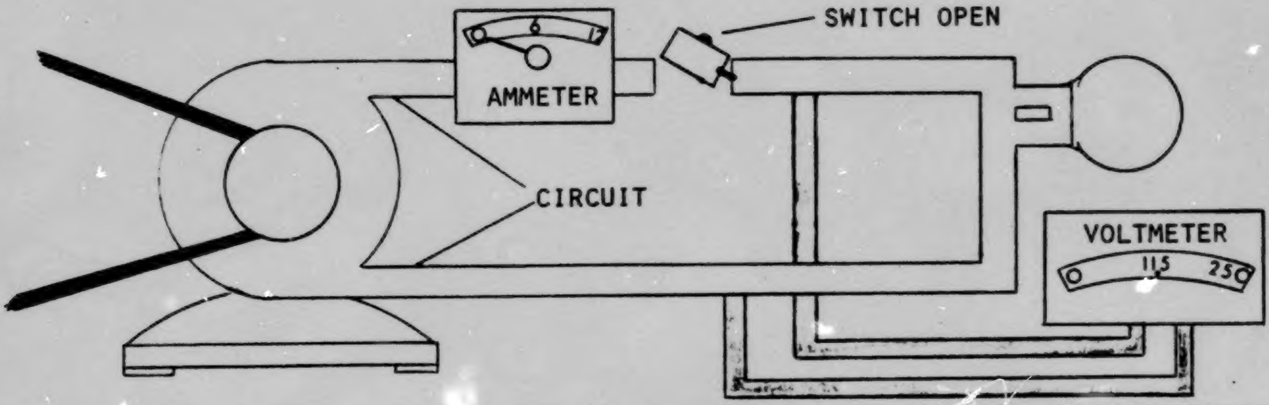
AMPERE

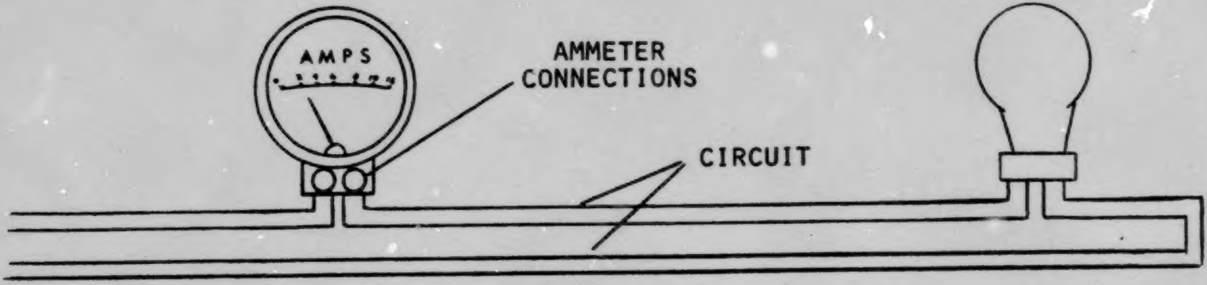

ONE AMPERE =
6,300,000,000
BILLION
ELECTRONS PER
SECOND
ONE AMPERE

TRANSPARENCY IV-1-J

AMPERAGE

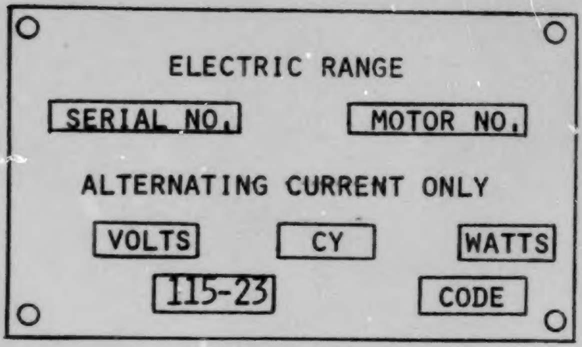

SWITCH CLOSED
0
6
12
AMMETER
AMMETER CONNECTIONS
VOLTMETER
0
115
250


SWITCH OPEN
0
6
12
AMMETER
CIRCUIT
VOLTMETER
0
115
250


AMPS
AMMETER CONNECTIONS
CIRCUIT

TRANSPARENCY IV-1-K

"VOLTAGE IDENTIFICATION"



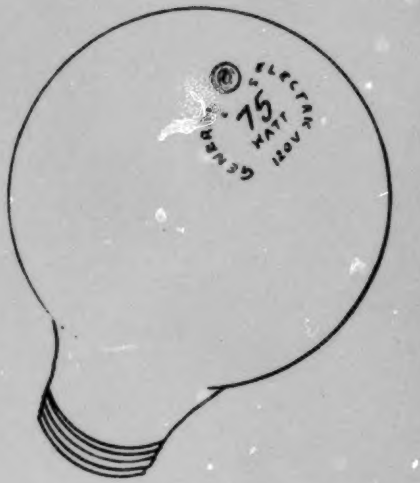
ELECTRIC RANGE

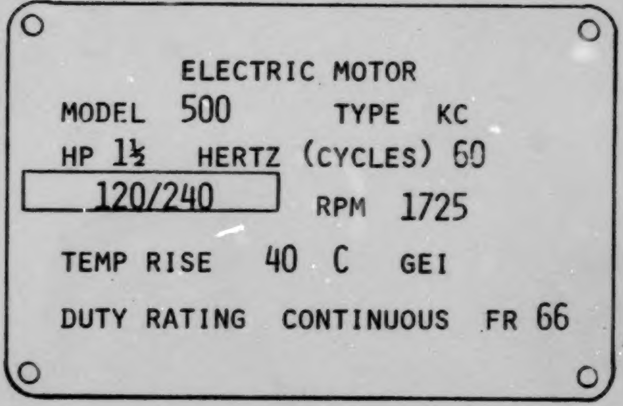
SERIAL NO. MOTOR NO.

ALTERNATING CURRENT ONLY

VOLTS CY WATTS

115-23 CODE


GENERAL ELECTRIC
75
WATT
120V



ELECTRIC MOTOR

MODEL 500 TYPE KC

HP 1½ HERTZ (CYCLES) 60

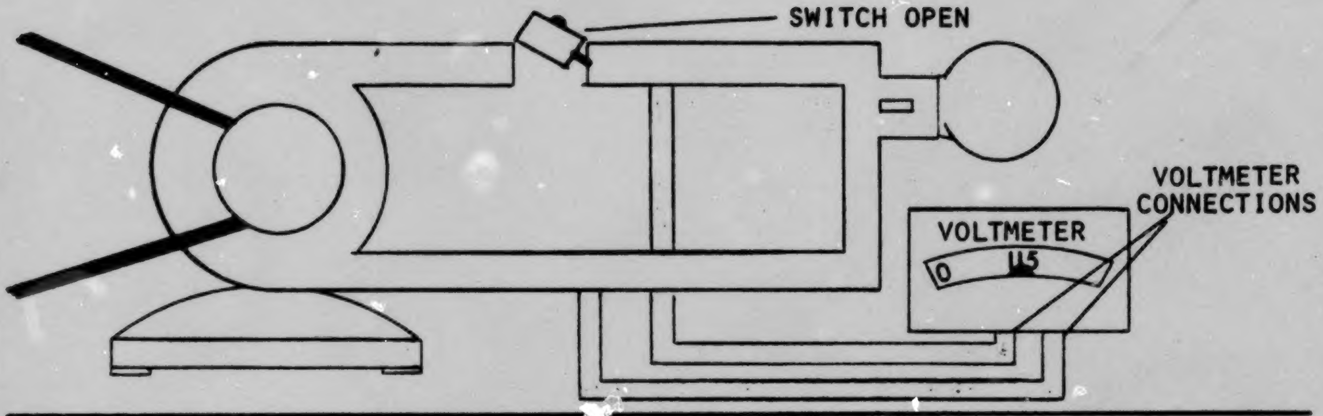
120/240 RPM 1725

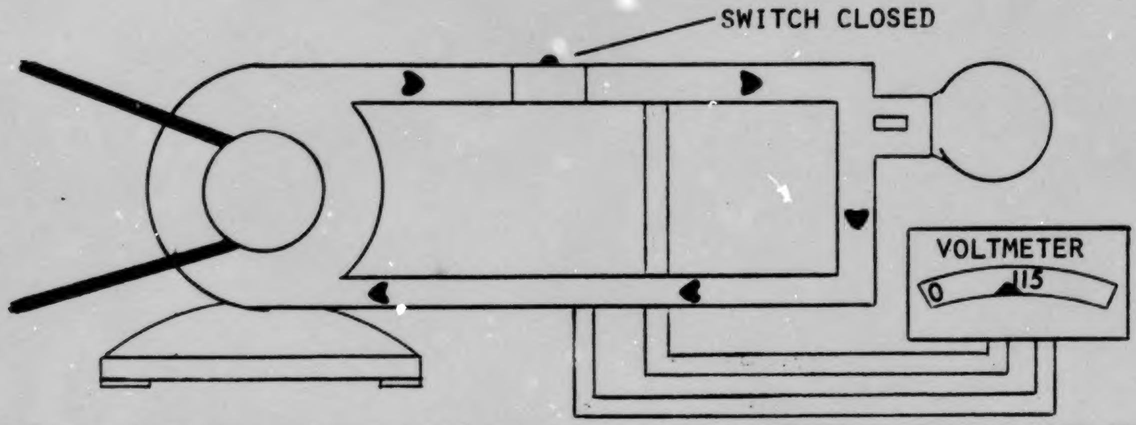
TEMP RISE 40 C GEI

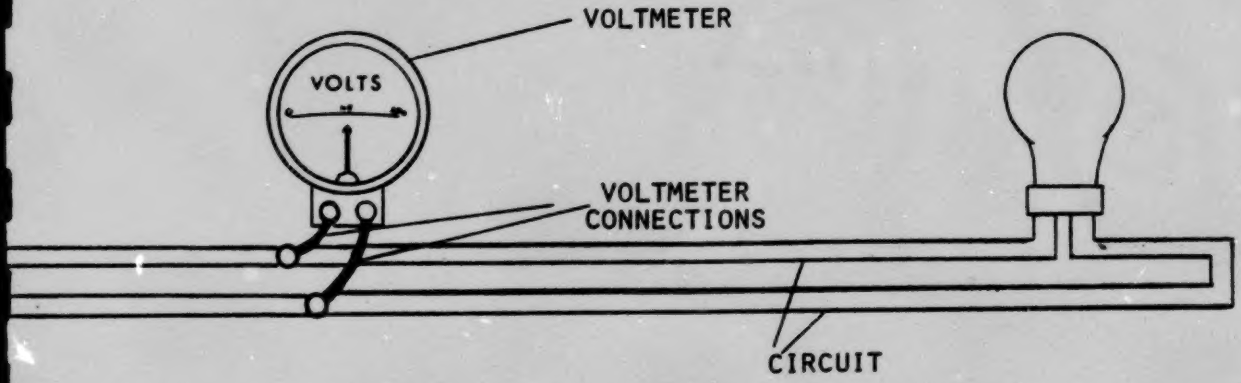
DUTY RATING CONTINUOUS FR 66

TRANSPARENCY IV-1-L

VOLTAGE


SWITCH OPEN
VOLTMETER CONNECTIONS
VOLTMETER
0
115


SWITCH CLOSED
VOLTMETER
0
115


VOLTMETER
VOLTS
VOLTMETER CONNECTIONS
CIRCUIT

TRANSPARENCY IV-1-M

OHMS LAWS

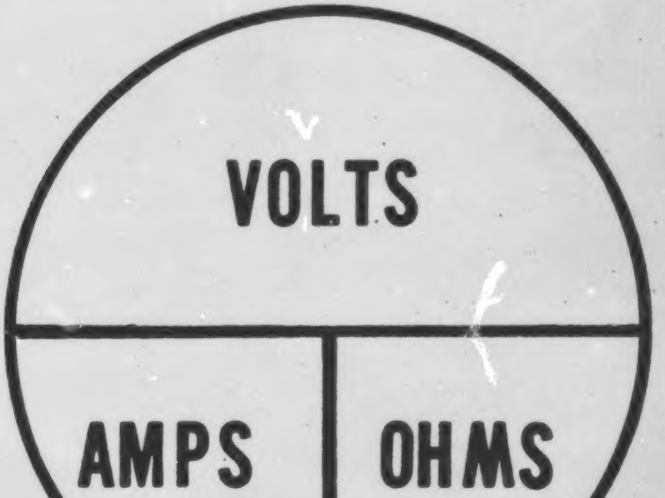
$$\text{OHMS (R)} = \frac{\text{VOLTS (V)}}{\text{AMPS (A)}}$$

OR

$$A = \frac{V}{R}$$

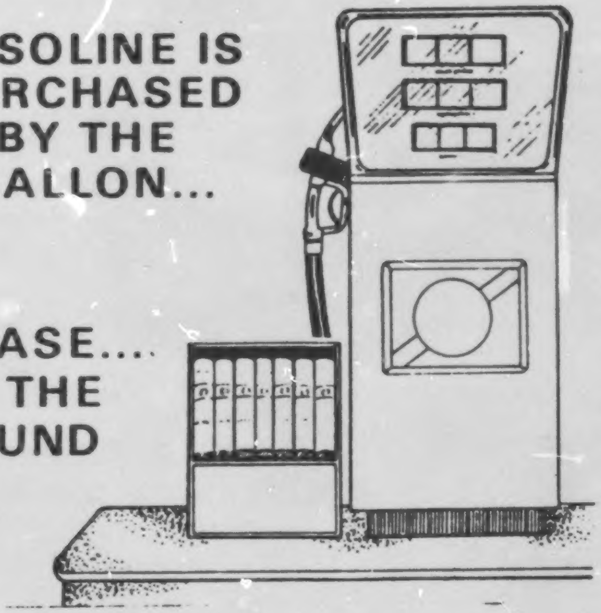
OR

$$V = A \times R$$


VOLTS
AMPS
OHMS

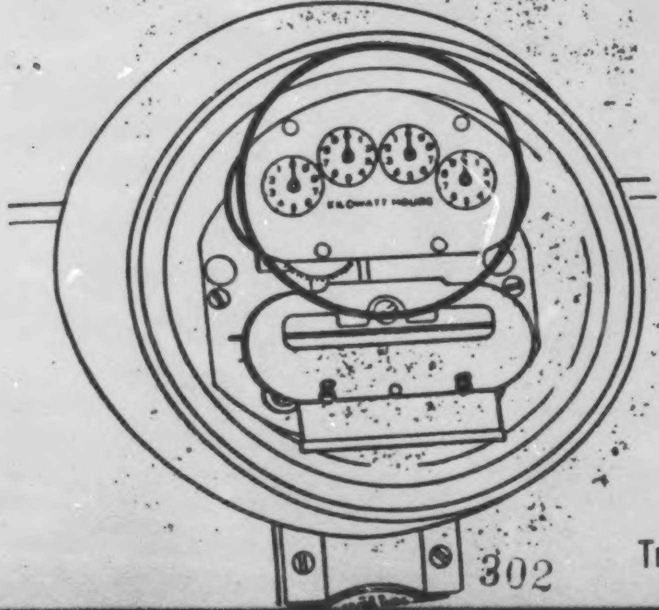
TRANSPARENCY IV-1-N

HOW ELECTRICAL ENERGY IS PURCHASED


GASOLINE IS PURCHASED BY THE GALLON...
GREASE.... BY THE POUND

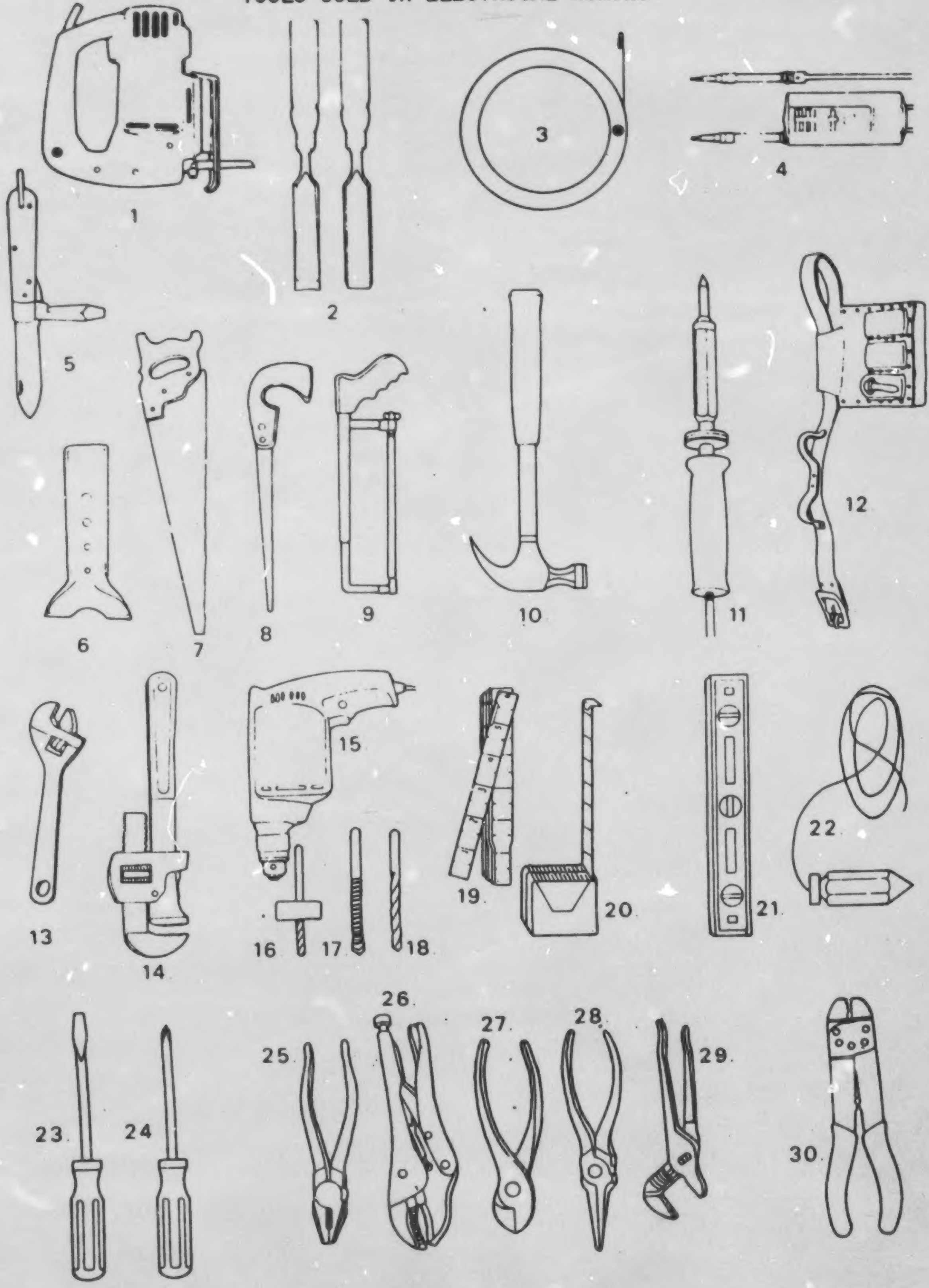
PEOPLE ARE ACCUSTOMED TO BUYING GASOLINE BY THE GALLON, AND GREASE BY THE POUND.

ELECTRICAL ENERGY IS MEASURED AND BOUGHT BY KILOWATT-HOURS.


ELECTRICAL ENERGY IS MEASURED IN KILOWATT-HOURS
KILOWATT HOURS

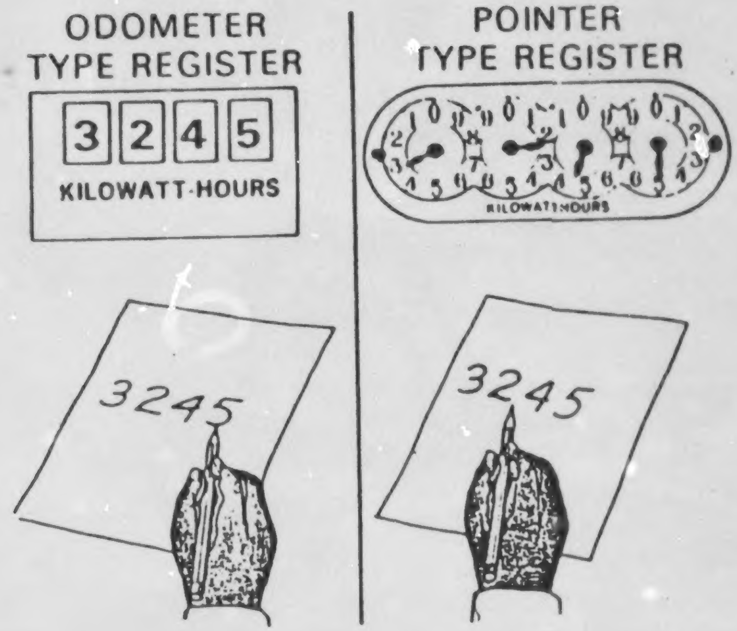
TRANSPARENCY IV-1-0

TOOLS USED IN ELECTRICAL WIRING

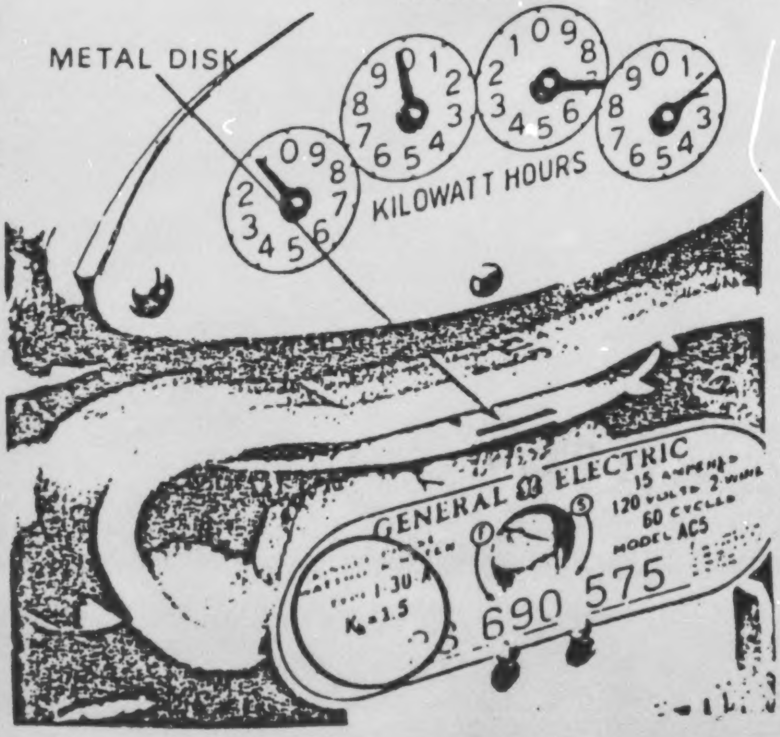

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

TRANSPARENCY IV-1-P

TWO TYPES OF METER READOUTS


ODOMETER TYPE REGISTER
3245
KILOWATT-HOURS
POINTER TYPE REGISTER
KILOWATT-HOURS
3245
3245

RECORDING THE METER READING AT THE BEGINNING OF THE PERIOD.


METAL DISK
KILOWATT HOURS
GENERAL ELECTRIC
15 AMPERES
120 VOLTS 2 WIRE
60 CYCLES
MODEL AC5
690 575
Kh 1.5

THE "KH 1.5" ON THIS METER MEANS THAT WITH EACH DISK REVOLUTION, 1.5 KILOWATT-HOURS ARE USED.

TRANSPARENCY IV-1-Q

READ NUMBER NEAREST POINTER AND RECORD

READ LAST NUMBER PASSED ON SECOND DIAL AND RECORD ON LEFT OF FIRST NUMBER

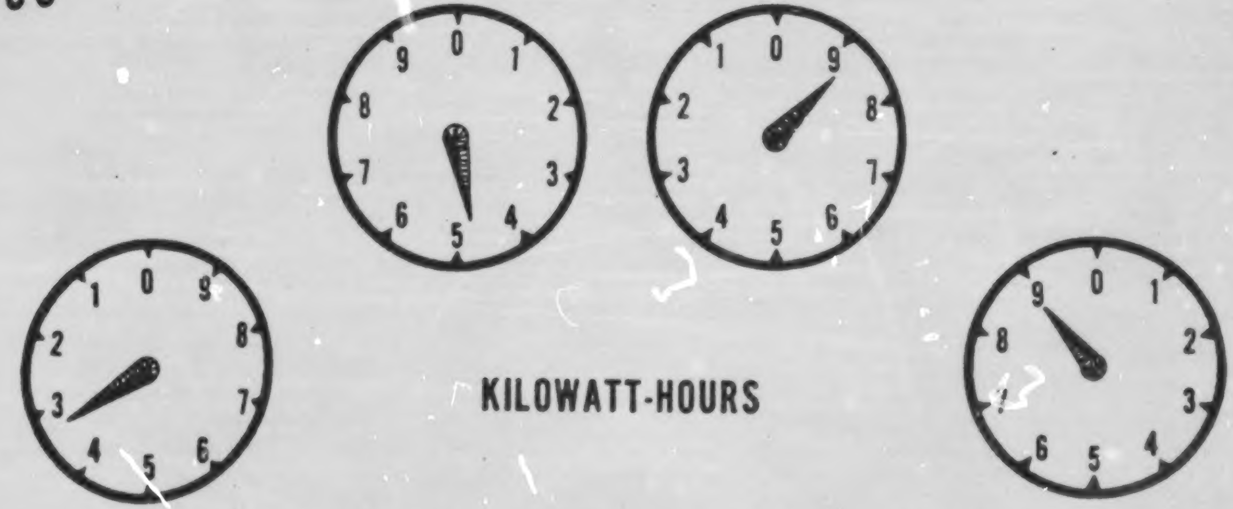
9

READ LAST NUMBER PASSED ON THIRD DIAL AND RECORD

89

READ LAST NUMBER PASSED ON FOURTH DIAL AND RECORD

489



KILOWATT-HOURS

TRANSPARENCY IV-1-R

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT IV: Electricity

LESSON 2: Skills Necessary in Practical Wiring

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Demonstrate skills that are required to wire single-pole switches, three-way switches, four-way switches, duplex receptacles, double-pole switches, and to make all necessary connections.

2. Specific:

a. Describe the proper procedure for removing the cable sheath.
b. Describe the proper procedure for removing insulation from wires.
c. Define splicing.
d. List the three types of solderless connectors.
e. Define the term "ground."
f. Explain why grounding an electrical circuit is important.
g. Describe how system and circuit grounding is accomplished.
h. Describe two different ways of grounding to a metal box.
i. List several types of receptacles.
j. Demonstrate the procedure to follow in connecting a 120-volt duplex receptacle.
k. Define the term "back-wired receptacles."
l. Describe how switches are related.
m. List the three types of common switches used in house wiring.
n. Demonstrate the procedure to follow in connecting single pole switches under the following conditions:
   1) Switch with switch source.
   2) Switch to one light.

o. Demonstrate the procedure to follow in connecting duplex receptacles under the following condition:
    1) Switch to both halves of the duplex receptacle.
    2) Switch to one half, other half "hot" at all times on a duplex receptacle.

p. List the four basic rules in wiring a three-way switch.

q. Demonstrate the procedure to follow in connecting three-way switches under the following conditions:
    1) Lighting outlet ahead of switches.
    2) Lighting outlet between switches.
    3) Lighting outlet at end of run.

r. Demonstrate the procedure to follow in connecting four-way switches.

B. Review of Teaching Materials

1. Colvin, Thomas S. *Electrical Wiring: Residential, Utility Buildings and Service Areas*. Athens, Georgia: American Association for Vocational Instructional Materials, 1979.

2. Colvin, Thomas S. *Maintaining the Lighting and Wiring System*. Athens, Georgia: American Association for Vocational Instructional Materials, 1980.

C. Special Arrangements

Have on hand various electrical devices (switches, cables, duplex receptacles, boxes, etc.), electrical tools, and other electrical equipment.

D. Materials required

1. Overhead projector and screen

2. Materials listed above

II. Presentation of Lesson

A. Motivation

1. A dependable wiring job depends to a great extent on good connections throughout the system. Wherever wires are attached to terminals or spliced together, take time to

make the connection correctly and prevent problems in the future.

2. Many wiring tasks performed in the area of agricultural mechanics can be accomplished by individuals who have a basic knowledge of electricity and electrical circuits. The alternative is to hire the work done.

B. Content Outline

1. The first step in preparing cable for connection in boxes is to remove the outer covering called a sheath, unless it was removed before the box was installed. A cut down the center of the cable will open the sheath making it easy to separate from the insulated wires inside. A knife blade will do the job but may cut through the insulation on the wires. Many prefer to use a cable ripper because it does not usually penetrate deep enough to cut the wire insulation (Transparency IV-2-A). Preparing cable for connections is discussed under the following headings:

   a. Removing cable sheath. Proceed as follows to remove cable sheath with cable ripper: (Transparency IV-2-A)

      1) Place the cutting edge of the tool where one desires the cut to start on the cable.
      2) Squeeze and pull to the end on the cable.
      3) Peel the sheathing and cut it loose with knife or side cutter.
      4) Remove any remaining paper and other filler.

   b. Removing insulation from wires. Insulation may be removed with a knife or a wire stripping tool. Proceed as follows:

      1) Using a knife, start the cut on the insulation at an angle to prevent cutting into the wire. (Transparency IV-2-A)

         A nick in the wire will weaken it and reduce current carrying capacity. Remove about 5/8 to 3/4 of a inch, depending on type of connection to be made.

      2) If wire strippers are used, insert wire into the correct wire gauge hole size on the tool and squeeze the handles.

         Be sure the hole size is correct or it will damage the wire. Squeeze to make the cut through the insulation and strip the insulation off the end of the wire (Transparency IV-2-A). This method does not cut into the wire.

2. Types of splices and connectors

   Splicing is the joining together of two or more wires to make a connection. Splices must conduct electricity as well as uncut wires to be sure of good electrical connections. Loose connections may allow arcing which could cause a fire or damage equipment when the system is placed in service.
   Soldering was once the accepted method of splicing wires but is seldom used in modern house wiring.
   Solderless connectors are available for most types and sizes of splices (Transparency IV-2-B). They are easy to use and make good connections quickly. There are several brands, but they are usually called wire nuts. Wire nuts are used for practically all splices in house wiring circuits. They are available to fit all sizes of commonly used wires in house wiring. The size of wire must be matched with correct wire nut size given on the package.

3. Splicing wires -- Remember, all splices must be enclosed in a box. There are two methods for splicing wires:

   a. Solderless: solderless splices may be made by the use of three different types of connectors. They are:

      1) Wire nut connectors are the most satisfactory. Proceed as follows:

         a) Remove insulation from wire ends. Use a wire stripper. Remove just enough insulation for the connector to cover the bare wire when tight (Transparency IV-2-B). Follow instructions on the box.

b) Hold wires side by side. It is not necessary to twist the wires together.

c) Place connector over wire end and turn as one would a nut until tight (Transparency IV-2-B).
Be sure both wires are locked in and no bare wires are exposed.

2) Crimped-connectors are used but may not be approved by some local codes. The wire ends are stripped and placed in a connector and crimped with a crimping tool. (Transparency IV-2-B).

3) Split-bolt connectors are normally used for large wires (Transparency IV-2-C). The wire ends are stripped and placed in the connector, and the nut is tightened.
The connection is then wrapped with layers of plastic electrical tape at least the same thickness as the original insulation.

b. Soldered

Wires may be spliced with solder. Wire ends are stripped, cleaned, and twisted together. The wire ends are heated with a soldering iron and rosin-core solder is melted by the heated wire. (Transparency IV-2-C).

4. Grounding the electrical system and equipment

A ground is an intentional connection between an electrical system and the earth. The preferred way to ground a house wiring system prior to the 1978 Code was to connect a conductor from the neutral bar in the Service Entrance Panel to a metal cold water pipe that is underground for at least 10 feet. This type of installation must now be supplemented by one or more additional grounding electrodes.

Grounding makes an electrical system 126 safer for people to use and prevents damage to the system and property. If circuits and equipment are not correctly grounded, one may get a severe or even fatal shock. Such items as appliances, power tools, and electric motors may be damaged or destroyed by a ground fault. A ground fault is an insulation failure between an energized (hot) conductor and the ground.

Grounding the electrical system and equipment will be discussed as follows:

a. Ground the system and circuits

Grounding the system and circuits covers all current-conducting parts of electrical installation, including the necessary wiring in the SEP and the circuits.

System and circuit grounding is accomplished by connecting the SEP neutral bar to ground and by connecting the white neutral wire from each circuit to the neutral bar. (Transparency IV-2-D)

In 120-volt installations there must be two conductors, one black and one white. The black wire is commonly referred to as the "hot" wire, but its technical name is the ungrounded conductor. The white wire is commonly called the neutral wire, but its technical name is grounded neutral conductor. Both wires carry current, but the white neutral wire is connected to ground through the neutral bar in the SEP (Transparency IV-2-D). The white neutral wire must be continuous throughout the system. How can this be done when the wire is cut at every box or outlet to make spliced connections?

It can be made electrically continuous by joining the cut ends with good solid connections at every box (Transparency IV-2-D). By joining white wire to white wire at every connecting point, one gets the same effect as having one continuous white wire. It runs from the SEP to every outlet in the circuit. One must not install a switch, a fuse or a circuit breaker in the neutral wire. The rule to remember is, the neutral is always white but the white wire is not always a neutral. The white wire is not a neutral if it is connected to a switch. In an exception to the Code requirements, the Code allows a white wire to be connected to a switch in some instances. This exception will be explained in detail under "Connecting Switches and Circuits."

b. Grounding the equipment

Equipment grounding covers the non-current-carrying parts of the system. Included are metal frames on equipment, appliances, and motors, and all metal boxes, switch boxes, receptacles, and metal conduit.

According to the Code, equipment is connected to ground for the following purposes:

1) To limit the voltage to ground on equipment frames and on metal enclosures of the wiring system.

2) To ensure operation of cover-current devices in case of ground faults.

The grounding wire is there to help protect a person from a dangerous shock or to protect equipment from damage in case of insulation failure in the circuit. If a ground fault occurs and the current in the line exceeds its overcurrent protection, the circuit breaker trips or the fuse opens, disconnecting the circuit.

In 120-volt house wiring using nonmetallic sheathed cable with ground, equipment grounding is accomplished by means of the bare grounding wire in the cable. It must be connected to the neutral bar in the SEP. The bare ground wire does not normally carry

current. From the neutral bar,
it must be connected to metal outlet boxes, to every outlet in the circuit, and to the frames of all equipment. The grounding wire may sometimes be insulated. If so, it must be green or green with yellow stripes.

c. To ground the system and circuits and the equipment, proceed as follows:

1) In the SEP, locate the end of the cable that is marked (for example) "clothes washer."

2) Remove the sheath and filler from the cable clamp to the ends of the cable.

3) Remove 3/4 inch of insulation from each insulated wire.

4) Insert the white neutral wire under a terminal screw on the neutral bar and tighten. On most neutral bars the wire-end is inserted under the terminal screws without a loop.

5) Insert the bare grounding wire under a separate terminal screw on the neutral bar and tighten the screw.

To complete the circuit wiring in the SEP, connect the black wire to the circuit breaker. Most have push-in set-screw types of connections. Snap the circuit breaker into position. Be sure it is the correct size for the conductor.

6) Connect the grounding wire to the metal box and to the receptacle grounding screw.

The bare grounding wire in the cable must be connected to the metal outlet box and to the green grounding screw on the receptacle (Transparency IV-2-E). The usual way to connect the grounding wire to a metal box is with a "jumper" wire, sometimes called a "pigtail," and a screw. The "jumper" wire is a short piece of wire, 4-6 inches in length. Another method of grounding the box is by means of a clip. Insert the end of the jumper wire into the clip and force the clip onto the edge of the box. Use of clips is not allowed by some local codes. (Transparency IV-2-E)

In single-gang plastic boxes, the ground wire is not required to be fastened to the box. The ground wires are fastened to each other and to the grounding terminal on the receptacle. (Transparency IV-2-E)

The Code permits the following exceptions to the required jumper wire for receptacle grounding:

a) Where the box is surface mounted, the metal to metal contact between the metal receptacle yoke and the box is permitted for grounding the yoke. (Transparency IV-2-F)

b) Contact receptacles or yokes designed and listed for the purpose are permitted for grounding the circuit between the yoke and flush types of boxes. Several manufacturers offer specially constructed receptacles which provide a ground between the receptacle yoke and box, thus eliminating the grounding screw and jumper wire. (Transparency IV-2-F)

5. Connecting circuits and receptacles

Connecting circuits and receptacles are discussed as follows:

a. Types, sizes, and colors of receptacles

The most common type of receptacle in house wiring is the standard grounding duplex receptacle. It is available in 15- and 20-ampere, 120-volt rating with a U-shaped opening as the grounding terminal. (Transparency IV-2-G)

Another type allows one 130
outlet to be wired for 15-ampere, 125 volts and one for 15-ampere, 250 volts (Transparency IV-2-G). Receptacles may be rated for 125 and 250 volts even though they are connected to 120 and 240 volts.

Other types and sizes of receptacles are the single receptacle, single receptacle with a switch, single receptacle with pilot light, and a duplex receptacle with weatherproof cover.

b. Connecting 120-volt duplex receptacles

Examine the duplex receptacle before starting to wire. Look at an example from the back (Transparency IV-2-H), note the two brass terminal screws on one side. Always connect a black wire or current-carrying wire to a brass terminal (black wire to dark terminal). On the opposite side are the two silver terminal screws. Connect only white wires to silver terminals (white wires to light terminals). The green hexagonal grounding screw is at the bottom on the right. (It may be at the top on some receptacles.) Connect the bare or green grounding wire to the green screw.

Some receptacles do not have different colored terminals. If not, the Code requires the word "white" to be located next to the terminals for the white neutral wires. Also, if the grounding terminal is not colored green, it must have the word "green" located next to it.

At the top and bottom center are the mounting screws. They fit the holes on the front of the box. Use these to mount the receptacle after the completion of the wiring. Plaster ears at bottom and top hold the receptacle in correct position if the box is set too deep.

Procedure to following in wiring the diagram as shown in (Transparency IV-2-H). No. 12-2 w/g cable is installed and clamped inside the device box. Allow 6 to 8 inches of cable to work with and mount the duplex receptacle with U-shaped ground opening at the bottom. Proceed as follows to connect the first receptacle in the circuit:

1) Remove cable sheath and filler and strip about 5/8 inch of insulation from the exposed insulated wires.

2) Make a loop of wire ends of the black and white wires as shown in Transparency IV-2-H.

   Leave an opening at the end of each loop so it can be easily placed under the screw terminal.

3) Connect the black (hot wire) to one of the brass-colored terminal screws on the receptacle.

   Place the loop on the terminal so it will tighten as the screw is turned clockwise. With pliers, pull the loop snug around the screw and tighten with a screwdriver. When tight, the insulation should run right up to the screw so bare wire doesn't show.

4) Connect the white (neutral) wire to a silver-colored terminal opposite the black wire connection.

   Install the wire loop under the silver terminal and tighten.

5) Connect the grounding wire.

   The wires may be connected to the receptacle in any order, but many people prefer to make the grounding connections first. The grounding wire in the cable is bare or, if insulated, green. The grounding wire must always be connected to every box. The grounding wire must be connected to both the box and the receptacle unless the receptacle is the type with special grounding yoke or the box is plastic. Wiring a receptacle that must be grounded to the box, two jumper wires must be utilized to connect the grounding wire(s) in the circuit cable, one from the box and the other from the receptacle.

Proceed as follows:

a) Connect the jumper wire to the grounding screw in the box.

Cut a 4 to 6 inch length of green insulated or bare wire and connect one end to the grounding screw in the box.

b) Cut a second 4 to 6 inch length of green insulated or bare grounding wire and connect one end to the green grounding terminal on the receptacle.

c) Complete the grounding wire connections.

Three wire ends must be brought together, the bare wire from the cable and the two jumper wires. Place the three ends of the wires together, attach a wire nut, and tighten.

The receptacle is now completely wired if only one cable enters the box. However, in this instance, one must connect a second outgoing cable to extend the run to other receptacles.

6) Connect second cable

To connect the second cable, attach the black wire to the second brass terminal screw and the white wire to the second silver-colored terminal screw.

Since the grounding connections have already been made to the receptacle and to the box, it is not necessary to repeat these steps.

7) Connect the bare grounding wire from the second cable to the grounding wire from the first cable.

Instead of three grounding wire ends fastened with a wire nut, there will now be four. Remove the wire nut and place the end of the grounding wire with the ends of the first three. Replace the wire nut and tighten. (On the job, connect all four grounding wires at once, realizing that the outgoing cable must be connected.) This completes connections to the receptacle and box for the incoming and outgoing cable.

8) Place the receptacle in the box

Bend the wires slightly so they will fold in accordion fashion. Push the receptacle into the box with wires folded behind.

9) Attach the receptacle to the box

The receptacle should be mounted so it is straight up and down. The box may sometimes tilt right or left. A wide slot is provided for the mounting screws at top and bottom of the receptacle to permit adjustments as needed.

10) Attach cover plate

After all finish work is completed on wall surfaces, attach the cover plate. Insert center screw to hold cover plate. (Transparency IV-2-I)

11) Connect back-wired receptacles

Many receptacles are made so 134
wiring can be connected to either side terminals or to back-wiring holes. Connections to back-wired receptacles are similar to side screw terminal connections. The difference is that wires are inserted into holes on the back of the receptacle (Transparency IV-2-J). Back-wired receptacles have a strip (depth) gauge on the receptacle to indicate the depth of the hole. The length of insulation to be removed from the wires must match the length of the strip gauge. When installing back-wired receptacles, proceed as follows:

a) Strip the correct length of insulation from the black and white wires.

b) Insert the wires into the holes.

With many back-wired devices, one needs only to insert the wire into the hole near the terminal screw to complete the connection. After the wire is inserted it is clamped automatically. With other back-wired devices, loosen a screw near the hole, insert the wire, and tighten the screw against the wire. Follow instructions on the carton or packing slip.

Insert the black wire into the hole near the brass terminal and the white wire into the hole near the silver terminal.

If the screw terminals are not identified by color, the hole for each white neutral wire must have a white ring around it or it must have the word "white" printed next to the hole.

If an outgoing cable for another receptacle is to be connected, repeat the procedure for black and white wires. Insert the wires in the holes provided near the second set of terminals.

A hole may not be provided for the bare grounding wire. Use the green grounding terminal screw if there is no terminal marked green. Make all grounding connections in the same way as with screw terminal receptacles.

5. Connecting switches and circuits

a. Types and sizes of switches

In house wiring, the switches that are installed will likely be AC switches for the control of lighting circuits. Most of those used in lighting circuits are toggle switches. Other kinds available are the rocker-type and push-button switches (Transparency IV-2-K). Older AC-DC switches are seldom used because the AC switches are quieter and lower in cost.

Switches have their safe ampere and voltage ratings stamped on the metal yoke and, if horsepower rated, their maximum rating. A switch may be rated for both 120-volt and 240-volt operation. For example, 10 amperes at 120 volts or 5 amperes at 240 volts. In others the switch may be rated only for 120-volt use. Check your switches before mounting to be sure the ratings are suitable for the circuit.

Switches are availabe in various combinations such as switch and receptacle, switch and pilot light, or with two switches on one strap. (Transparency IV-2-K)

As with receptacles, switches may be either side-wired or back-wired or both. Other useful variations are the time-delay switch and the rotary-dimmer switch (Transparency IV-2-K).

The time-delay switch turns lights on as an ordinary switch. However, when turned to "delay," which is the "off" position, the lamp remains "on" for a convenient period of time. In the garage, for example, it will allow time to enter a car comfortably before the lamp turns "off."

A rotary-dimmer switch turns the lamp to any level of lighting desired from "off" to full brightness. Dimmer switches are often used to control lighting levels in living and dining rooms.

Both time-delay and rotary-dimmer switches are mounted in standard switch boxes. Both connect in the circuit in the same manner as standard single-pole switches.

The three most common types of switches used in house wire differ in their internal wiring. Terminals may be located on ends, front, or sides. The three types are:

1) Single-pole switches,

2) Three-way switches, and

3) Four-way switches.

(Transparency IV-2-L)

b. Connecting single-pole switches

A single-pole switch controls lighting from one position. But one single-pole switch may control several lights or receptacles on the same circuit. Wiring connections could be different for one or two or more lights on a circuit. Connections differ depending on whether the power source enters the circuit at the switch or through an outlet. The term source is used to indicate the power source from the SEP.

The Code requires that metal switch boxes be grounded. But the switches themselves do not usually have a grounding terminal unless used for a special purpose. So, unlike receptacles, the pigtail grounding wire is not normally required to be connected from box to switch.

A jumper wire is required to connect the grounding wire at the lighting outlet box only if the circuit continues to another outlet. If the outlet is at the end of the circuit, the bare wire connects directly to the grounding screw in the outlet box. Make all required connections at each outlet or switch before moving to another.

Both of the above grounding situations can be applied when the current from the SEP enters at the switch box (source). The bare grounding wire is connected to the grounding screw in the switch box by a jumper wire. The ends of the bare wire from the cables are connected to the jumper wire with a wire nut.

At the outlet box for the light, the bare grounding wire is connected directly to the grounding screw on the metal box. No jumper is required because the circuit does not continue beyond the lighting outlet.

Connecting single-pole switches is discussed as follows:

1) Connecting single-pole switch with switch source

   Single-pole switches control lights from one position. The lever is marked "off" and "on."

   a) Connect the black wire from the source cable to one terminal on the switch.

   b) Connect the black wire from the outgoing cable to the other switch terminal.

c) Connect the white neutral wire from each cable with a wire nut.

Note that the white neutral wire does not connect to the switch. Neutral wires do not connect to switches.

d) Connect the bare grounding wire.

Connect the jumper wire to the screw in the switch box. Place the ends of the bare wire from each cable together with the jumper wire and fasten with a wire nut.

e) Connections made in the outlet box are as follows:

(1) Connect the grounding wire to the grounding screw in the outlet box.

(2) Connect cable wires to fixture terminals.

Connect black wire to brass and white wire to silver terminal.

2) One single-pole switch to one light outlet. Assume the source cable is to enter the lighting outlet box first, proceed as follows: (Transparency IV-2-M)

a) Connect wiring at the light outlet.

(1) Connect white wire from the switch to black wire from source cable.

Remember that an exception was noted in the first discussion of Code requirements regarding the white wire in a cable. The exception is as shown in a switch loop, sometimes called a switch leg. A switch loop is required when the power source enters the lighting outlet box first.

The Code permits connecting the white wire in a cable to a switch, provided it is used for the supply to the switch but not as a return conductor from the switch to the switched outlet.

In this instance and all others where permitted, the white wire is used as if it were a black wire. The reason it is permitted is that two-wire cable is made only with one black and one white wire, not two black wires. This white wire is considered an unidentified or "hot" wire.

(2) Connect black wire from switch to brass terminal on the fixture.

(3) Connect white wire from source to silver terminal on fixture.

(4) Connect bare grounding wires.

Connect pigtail grounding wire to ground screw in switch box. Connect wire ends from pigtail wire, source cable, and switch box cable with wire nut.

b) Connect wiring at the switch.

(1) Connect the black wire to one switch terminal.

(2) Connect the white wire to the other switch terminal.

(3) Connect bare grounding wire to box grounding screw. 140

c. Connecting switched duplex receptacles

Switched duplex receptacles are often installed in living areas of the home. Table lamps supplying part or all of the lighting are more convenient to use if connected to a switched receptacle that can be turned on when entering a room. The switch may control both outlets on the receptacle or only one.

To connect the switch to both halves of a duplex receptacle outlet, proceed as follows: (Transparency IV-2-M)

1) Connect wiring at the receptacle.

   Connect black wire from switch to either brass terminal. Connect white wire from switch to black wire from source cable. Connect white wire from source cable to silver terminal on receptacle.

2) Connect cable going to next receptacle.

   Connect black wire to brass terminal and white wire to silver terminal.

3) Connect grounding wires.

   Connect grounding wires as in previous sections.

4) Connect wiring at the switch.

   Connect the black wire to one terminal and white wire to the other terminal.

It is often desirable to have one half of the receptacle controlled by a switch and the other half remain constantly hot.

Proceed as follows:

1) Remove connecting tab between two brass terminals of the receptacle.

   Use screwdriver or pliers to remove tab. The outlets are no longer electrically connected on the hot side after the tab is removed. (Transparency IV-2-J)

2) Connect wiring at receptacle

   Procedures are the same as for a single circuit except for one black jumper wire to a brass terminal. Connect black source wire to a black jumper and white wire from switch. Connect black jumper to lower brass terminal. The jumper wire makes the lower outlet constantly hot (not controlled by switch). Connect the black wire from switch to the top brass terminal. This outlet is controlled by the switch. Connect source white wire to silver terminal.

3) Connect wiring at the switch.

   Connect black wire to one terminal and white wire to other terminal. Connect grounding wire to grounding screw in box.

4) Connect grounding wires as in previous sections.

d) Connecting three-way switches

Three-way switches make it possible to switch lighting fixtures on or off from either of two locations. Why not three locations if they are three-way switches? The three-way description refers to the number of terminals on the switch, not the number of locations. Three-way switches have three terminals instead of two, as on single-pole switches. With three-way switches, it is convenient to turn lights on or off without retracing steps. The light may be turned on at the switch near door "A" and turned off at the switch near door "B." Three-way switches are also useful in long halls, stairways, and between the house and garage.

Three-way switches are used only in pairs. The toggle (handle) on a three-way switch is not marked for "on-off" position. Either up or down position may switch the light on or off, depending on the position of the toggle on the other switch.

On a three-way switch, one of the three terminals is a common or pivot terminal. A person must identify the common terminal to wire the switch correctly. The common terminal may be a different color from the other two, usually darker. But on some switches the word "common" is printed next to the common terminal, and it is often alone or on one side, but location varies with manufacturers. The carton or packing slip will indicate its location on the switch if not otherwise identified.

There are several possible combinations of lights and switches in three-way switch wiring. As with single-pole switches, connections are different depending on where the power source enters the circuit. Also, the position of the light fixture in relation to the switches affects the wiring procedures.

The power source of the three-way switch circuits is two-wire cable (14-2 w/g or 12-2 w/g). For wiring between the switches, three-wire cable must be utilized. (Transparency IV-2-N)

Rules for wiring every three-way switch

Wiring procedures for three-way switch circuits can be confusing, especially in the beginning; however, there are rules for wiring that will simplify the wiring procedures if carefully observed. For every three-way switch circuit, the rules are as follows:

1) Connect white wire from source to silver terminal on the light fixture.

   It will be spliced on some circuits but not connected at any other point.

2) Connect black wire from source to common terminal of either switch.

3) Connect black wire from brass terminal on light fixture to common terminal of the other switch.

   These three steps complete the connection to the common terminals on each switch and to both terminals on the light fixture.

4) To complete the circuit, connect the two remaining wires.

   These are called switching wires, or traveler wires. Switching wires connect from the two lighter colored terminals of one switch direct to the two lighter colored terminals of the other switch. They connect to nothing else.

   The two terminals for the switching (traveler) wire connections are usually a lighter color than the common terminal. For this discussion, they are referred to as light-colored terminals.

   Connect the two light-colored terminals on one switch to the two light-colored terminals on the other switch.

Wiring three-way switches with lighting outlet ahead of switches using light outlet source. (Transparency IV-2-O) Wiring from the source to the first switch box on the circuit is 14-2 w/g or 12-2 w/g cable. Three-wire w/g cable is used between the switches. Insulation on wires in three-wire cables is usually black, white, and red. Proceed as follows:

1) Connect wiring in lighting outlet box.

   a) Connect white wire from the source cable to silver terminal on lighting fixture.

   b) Connect black wire from common terminal of switch No. 1 to brass terminal on light fixture.

   c) Connect black wire from source to white wire from switch No. 1.

      This white wire is spliced as switch box No. 1 to the white wire in the three-wire cable and continues to switch No. 2 common terminal. As in the case of previous switched circuits, the white wire serves as a hot wire for the supply side of the switch circuit, and the Code does not require it to be identified (painted black).

   d) Connect grounding wires as in previous sections.

2) Connect wiring to switch No. 1 and box.

   a) Splice white wire from lighting outlet cable to white wire from cable to second switch (used as hot wire to switch No. 2).

   b) Connect black wire from lighting outlet cable to common terminal on switch No. 1.

   c) Connect black wire from three-wire cable to a light-colored terminal on switch No. 1 (switching wire).

   d) Connect red wire from three-wire cable to other light-colored terminal (switching wire).

        e) Connect grounding wires and ground the switch box.

    3) Connect wiring to switch No. 2 and box.

        a) Connect white wire to common terminal of switch No. 2.

        b) Connect black wire to a light-colored terminal of switch No. 2.

        c) Connect red wire to a light-colored terminal of switch No. 2.

        d) Connect grounding wire.

In order to wire three-way switches with lighting outlet between switches using switch source, (Transparency IV-2-O) proceed as follows:

1) Connect wiring at switch No. 1 (source).

    a) Connect black wire from source cable to common terminal of switch.

    b) Splice white wire from source cable to white wire from outgoing cable to lighting outlet box.

    c) Connect black wire from outgoing cable to light-colored terminal on switch No. 1.

    d) Connect red wire from outgoing cable to other light-colored terminal on switch No. 1.

    e) Connect grounding wires.

2) Connect wiring to lighting outlet box.

    a) Connect white wire from switch No. 1 cable to silver terminal on light fixture.

- b) Splice black wire from switch No. 1 cable to white wire from switch No. 2 cable.
- c) Splice together red wires from each cable.
- d) Connect black wire from switch No. 2 cable to brass terminal on light fixture.
- e) Connect grounding wires.

3) Connect wiring to switch No. 2.
    - a) Connect black wire to common terminal.
    - b) Connect red wire to light-colored terminal.
    - c) Connect white wire to other light-colored terminal.
    - d) Connect grounding wire.

To wire three-way switches with light at end of run using a switch source (Transparency IV-2-P), proceed as follows:

1) Connect wiring in switch No. 1.
    - a) Connect black source wire to common terminal of switch No. 1 and white source wire to white wire in three-wire cable going to switch No. 2. Connect red and black wires (switching wires) from three-wire cable to light-colored terminals.
    - b) Connect grounding wires.

2) Connect wiring in switch No. 2.
    - a) Connect black wire from outgoing cable to switch No.2's common terminal.

      This wire also connects to brass terminal of fixture.

b) Splice white wire to white wire.

c) Connect black wire and red wire from switch No. 1 to switch No. 2's other two terminals.

d) Connect grounding wires.

3) Connect wiring to lighting fixture.

a) Connect black wire to brass terminal and white wire to silver terminal.

b) Connect grounding wire to box.

e) Connecting four-way switches

Four-way switches are used only in combination with two three-way switches to control lighting from three or more locations. A circuit containing two three-way switches and one four-way switch gives control from three locations (Transparency IV-2-P). By adding four-way switches to the circuit, any number of desired control locations can be achieved from the same lighting outlet(s). Four-way switches are so called because they have four terminals. Installation of four-way switches is easier than the three-way. Use three-wire cable between all switches and two-wire cable between the light and the first switch.

If there is a need to control a light from three locations, install 14-3 w/g cable between switches and 14-2 w/g cable between lighting outlet and first switch.

Steps for connecting four-way and three-way switches with source at the lighting outlet are as follows: (Transparency IV-2-Q)

1) At the fixture, connect the black wire from switch No. 1 to the brass terminal on the fixture. Connect the white wire from the source to the silver terminal on the fixture.

Splice black wire from source to white wire going to the box at switch No. 1. 148

2) At the box for switch No. 1, splice black wire from switch No. 2 to the white wire going toward the fixture. Connect white and red wires from switch No. 2 to the light-colored terminals. Connect black wire from light fixture to common terminal on switch No. 1.

3) At the box for switch No. 2, the four-way switch, splice together the black wires from incoming and outgoing cable. The black wire does not connect to switch No. 2. Connect the switching wires, white wires from both cables, to terminals on one side. Connect red wire from switch No. 3 to terminal opposite white wire from switch No. 3. Connact second red wire to remaining terminal.

4) At switch No. 3, connect the black wire to the common terminal, white wire to a light-colored terminal, and red wire to the other light-colored terminal.

5) Connect grounding wires at each box.

f) Connecting double-pole switches.

A 240-volt circuit has two hot wires. The switch for a 240-volt circuit must be a double-pole type so both hot wires will be broken when the switch is turned off. Wire the switch and receptacle connections as shown in Transparency IV-2-Q. Wrap white wires with black tape at each terminal to show they are hot.

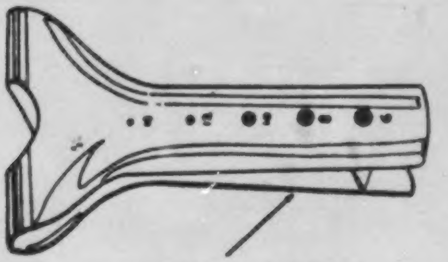
C. Suggested Student Activities

1. Assign students two to a group. Have them work the following problems (diagram and draw schematic) on a wiring board:

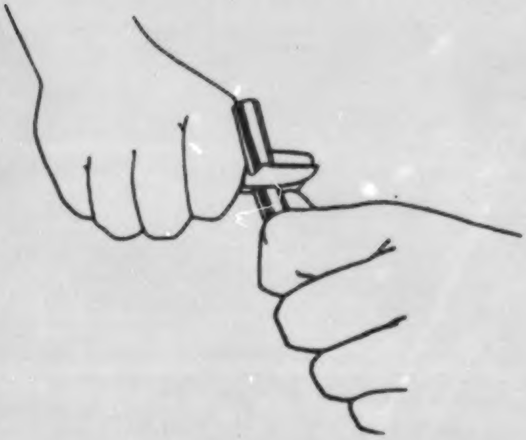
a. Draw the schematic and wiring diagram for a ceiling light controlled by three switches -- one 4-way and two 3-way switches. The unswitched duplex receptacle is to be hot at all times. Show cable run and connections to the disconnect switch. Source cable from disconnect switch is to enter ceiling outlet box.

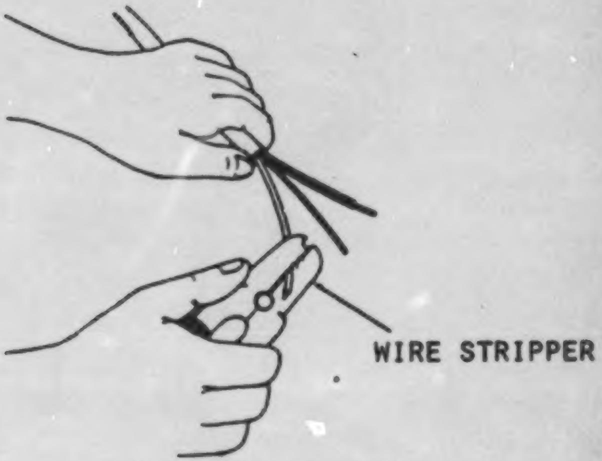
b. Draw the schematic and wiring diagrams for a ceiling light controlled by a wall switch and one half of a convenience outlet controlled by the other wall switch. The other half of the convenience outlet stays hot all the time. Show cable run and connections to fused disconnect switch. Source cable (from disconnect switch) is to enter ceiling outlet box.

TOOLS USED IN REMOVING SHEATH AND INSULATION FROM THE CONDUCTORS



CABLE RIPPER USED TO OPEN THE SHEATH ON NONMETALLIC SHEATHED CABLE.



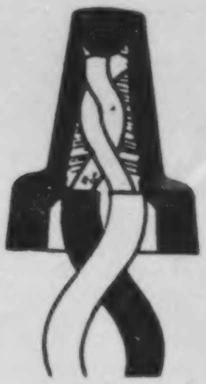


TO REMOVE INSULATION WITH A KNIFE, START THE CUT AT ANGLE TO PREVENT A NICK IN THE WIRE.

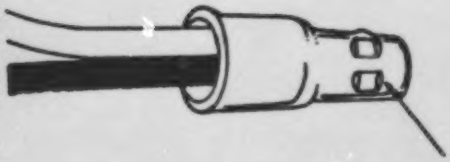
TO REMOVE INSULATION WITH A WIRE STRIPPER, MATCH STRIPPER NOTCH TO WIRE SIZE, INSERT THE WIRE, SQUEEZE THE HANDLE AND STRIP THE INSULATION OFF THE WIRE.

TRANSPARENCY IV-2-A

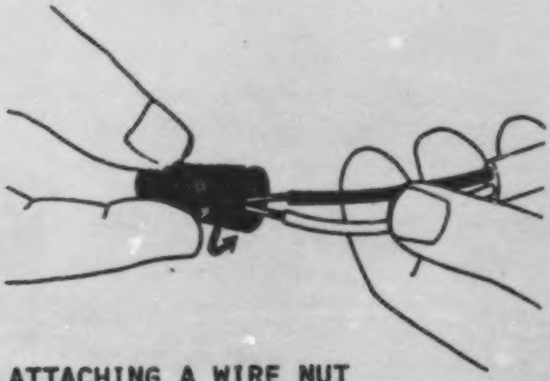
CONNECTING CONDUCTORS



THE AMOUNT OF INSULATION TO REMOVE DEPENDS ON SIZE OF WIRE AND WIRE NUT.



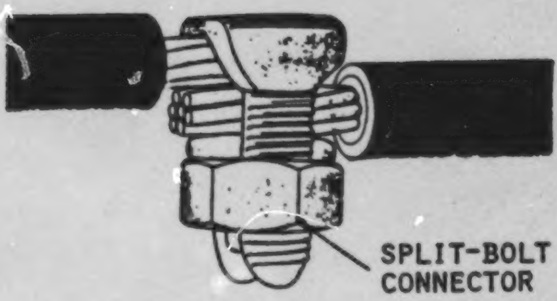
A CRIMP-CONNECTOR SPICE.

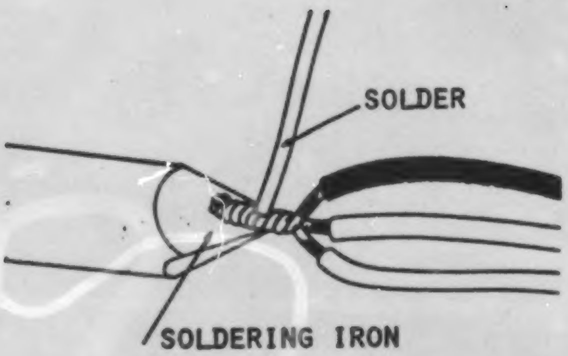


ATTACHING A WIRE NUT (SOLDERLESS CONNECTOR).

TRANSPARENCY IV-2-B

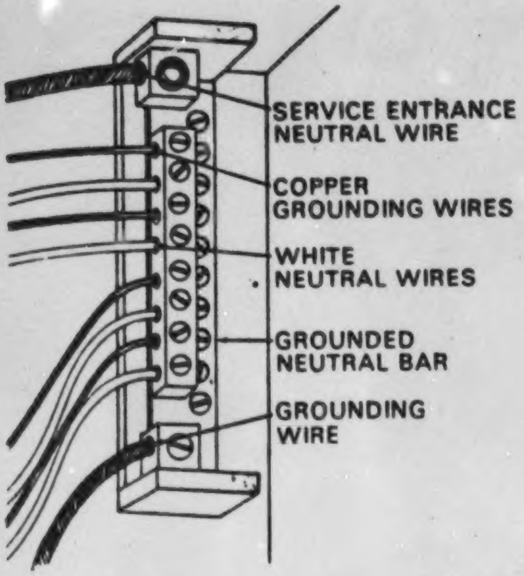
CONNECTING CONDUCTORS


SPLIT-BOLT CONNECTOR

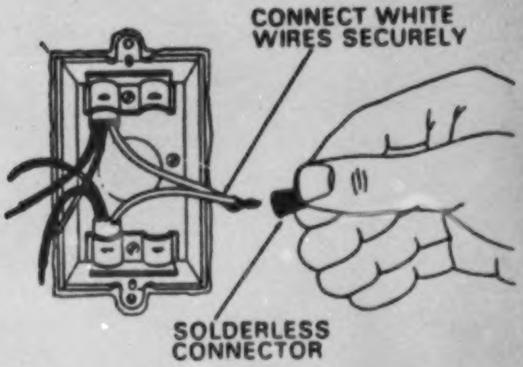

SOLDER
SOLDERING IRON

SOLDERING A SPLICE. HEAT WIRES WITH SOLDERING IRON UNDERNEATH TO MELT SOLDER.

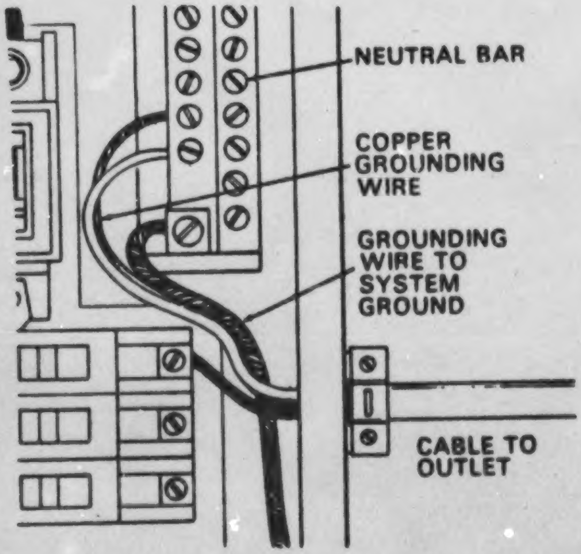
GROUNDING THE SYSTEM


SERVICE ENTRANCE
NEUTRAL WIRE
COPPER
GROUNDING WIRES
WHITE
NEUTRAL WIRES
GROUNDED
NEUTRAL BAR
GROUNDING
WIRE

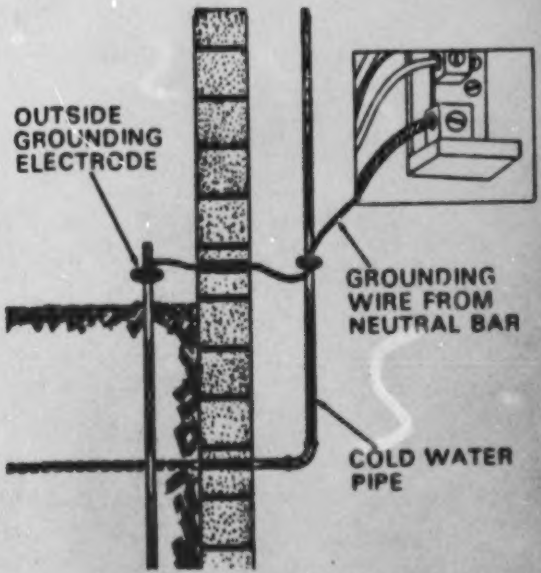
WHILE NEUTRAL WIRES MUST BE CONNECTED TO GROUNDED NEUTRAL BAR IN THE SERVICE PANEL FOR EACH CIRCUIT.


CONNECT WHITE
WIRES SECURELY
SOLDERLESS
CONNECTOR

THE WHITE NEUTRAL WIRE MUST BE MADE CONTINUOUS BY SPLICED CONNECTIONS AT EACH BOX OR OUTLET IN THE CIRCUIT.


NEUTRAL BAR
COPPER
GROUNDING
WIRE
GROUNDING
WIRE TO
SYSTEM
GROUND
CABLE TO
OUTLET

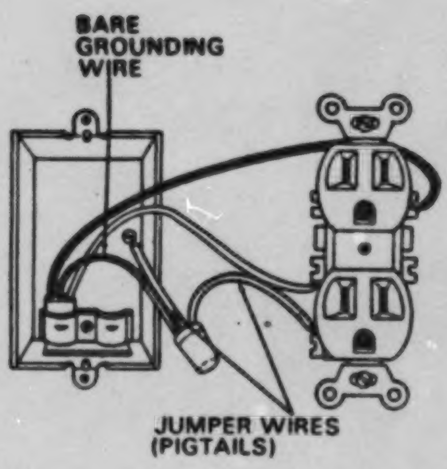
THE GROUNDING WIRE MUST BE CONNECTED TO THE NEUTRAL BAR IN THE SEP.


OUTSIDE
GROUNDING
ELECTRODE
GROUNDING
WIRE FROM
NEUTRAL BAR
COLD WATER
PIPE

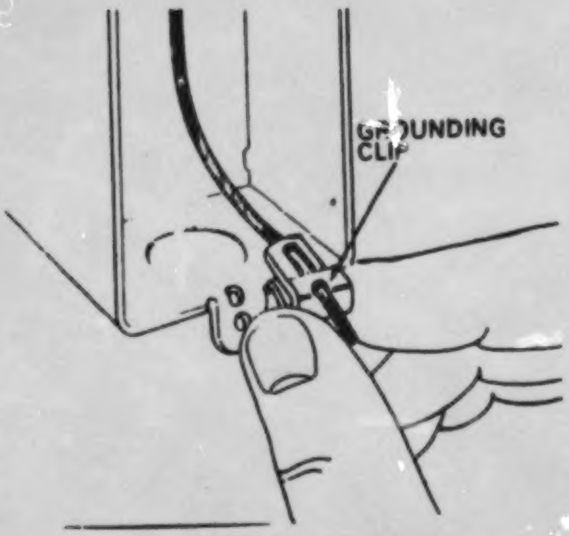
THE METAL WATER-PIPE GROUNDING ELECTRODE SUPPLEMENTED BY ADDITIONAL ELECTRODE TO CONFORM TO THE 1978 CODE.

TRANSPARENCY IV-2-D

GROUNDING THE DUPLEX RECEPTACLE AND THE BOX


BARE GROUNDING WIRE
JUMPER WIRES (PIGTAILS)

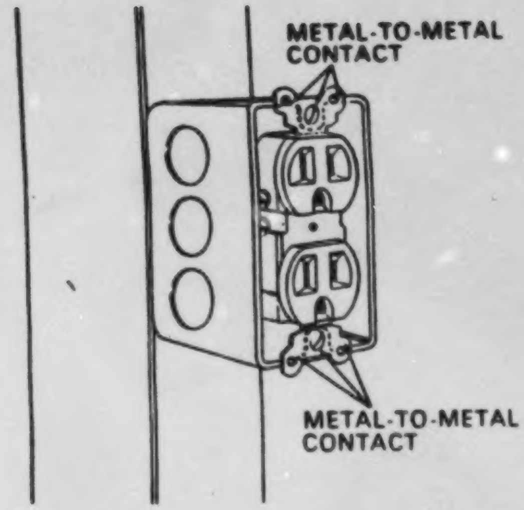
CONNECT THE BAR GROUNDING WIRE FROM THE CABLE TO THE RECEPTACLE GROUNDING SCREW AND TO THE BOX, USING TWO JUMPER WIRES AND A WIRE NUT SOLDERLESS CONNECTOR.


GROUNDING CLIP

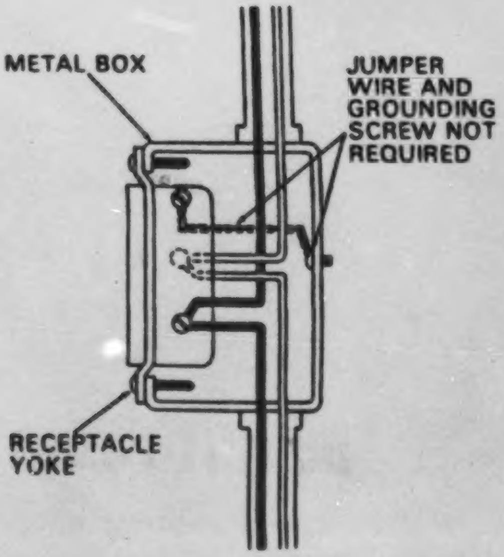
A GROUNDING CLIP FASTENS THE JUMPER WIRE TO THE EDGE OF THE BOX.

TRANSPARENCY IV-2-E

GROUNDING THE BOX


METAL-TO-METAL CONTACT
METAL-TO-METAL CONTACT

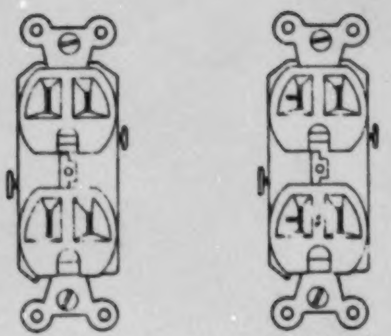
SURFACE-MOUNTED BOXES HAVING METAL-TO-METAL CONTACT BETWEEN THE RECEPTACLE AND BOX ARE CONSIDERED TO BE GROUNDED.


METAL BOX
JUMPER WIRE AND GROUNDING SCREW NOT REQUIRED
RECEPTACLE YOKE

RECEPTACLES WITH YOKES THAT ARE DESIGNED AND LISTED FOR THE PURPOSE MAY BE INSTALLED WITHOUT A GROUNDING WIRE TO THE BOX.

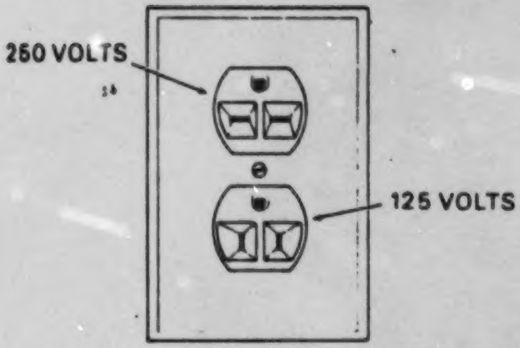
TRANSPARENCY IV-2-F

TYPES OF DUPLEX RECEPTACLES


15AMPS. 125 VOLTS

20 AMPS. 125 VOLTS

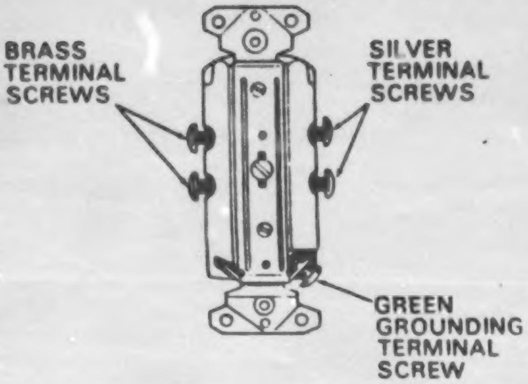
STANDARD GROUNDING DUPLEX RECEPTACLES.



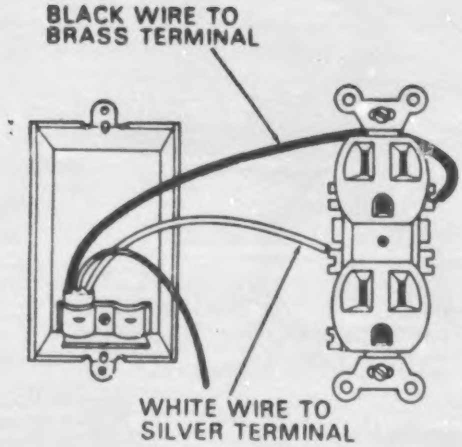
GROUNDED DUPLEX RECEPTACLE RATED AT 15 AMPERES, 125 VOLTS IN UPPER OUTLET AND 15 AMPERES, 250 VOLTS IN LOWER OUTLET. NOTE THE ARRANGEMENTS OF OPENINGS, PARALLELED FOR 125 VOLTS AND TANDEM FOR 250 VOLTS.

TRANSPARENCY IV-2-G

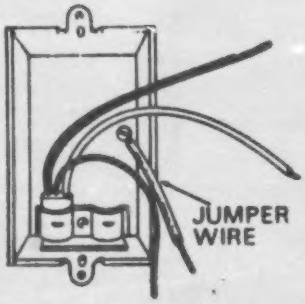
MAKING THE RIGHT CONNECTIONS

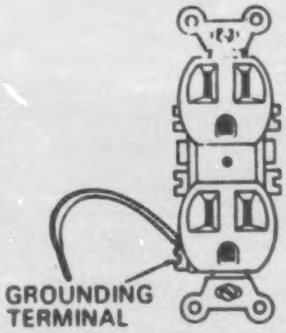

BRASS TERMINAL SCREWS
SILVER TERMINAL SCREWS
GREEN GROUNDING TERMINAL SCREW

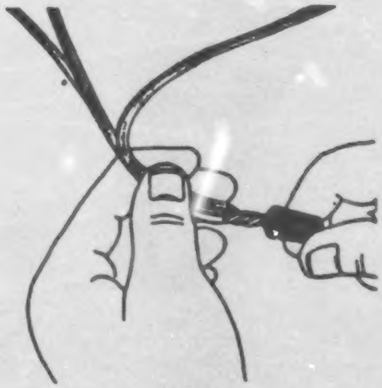
BRASS-COLORED TERMINALS FOR BLACK WIRE, LIVER-COLORED TERMINALS FOR WHITE WIRES AND GREEN TERMINAL FOR GROUNDING WIRE.


BLACK WIRE TO BRASS TERMINAL
WHITE WIRE TO SILVER TERMINAL

CONNECT BLACK WIRES TO BRASS TERMINALS AND WHITE WIRES TO SILVER TERMINALS ON THE RECEPTACLE. PLACE THE LOOP UNDER THE SCREW TERMINAL SO IT WILL TIGHTEN AS THE SCREW IS TURN.


JUMPER WIRE

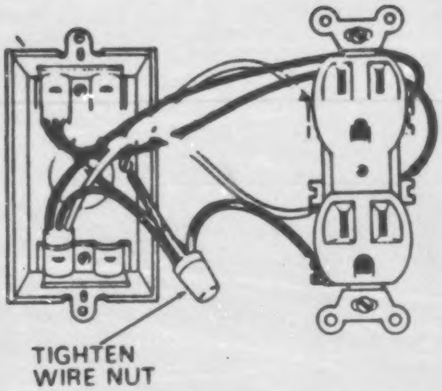

GROUNDING TERMINAL



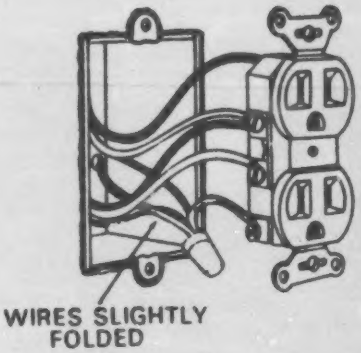
CONNECT ONE JUMPER WIRE TO THE BOX GROUNDING SCREW AND ONE TO THE RECEPTACLE GROUNDING SCREW. PLACE THE ENDS OF THE JUMPER WIRES TOGETHER WITH THE GROUNDING WIRE FROM THE CABLE AND FASTEN TOGETHER WITH A WIRE NUT.

TRANSPARENCY IV-2-H

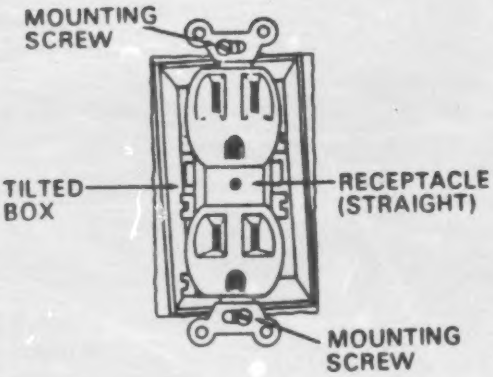
STEPS IN WIRING A DUPLEX RECEPTACLE


TIGHTEN
WIRE NUT

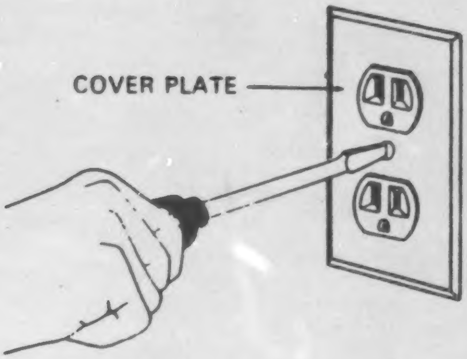
WHERE YOU HAVE TWO CABLES ENTERING THE BOX, PLACE THE ENDS OF THE TWO CABLE GROUNDING WIRES TOGETHER WITH ENDS OF THE TWO JUMPER WIRES AND FASTEN WITH A WIRE NUT.


WIRES SLIGHTLY
FOLDED

FOLD WIRES ACCORDION STYLE TO PUSH THEM INTO THE BOX MORE EASILY.

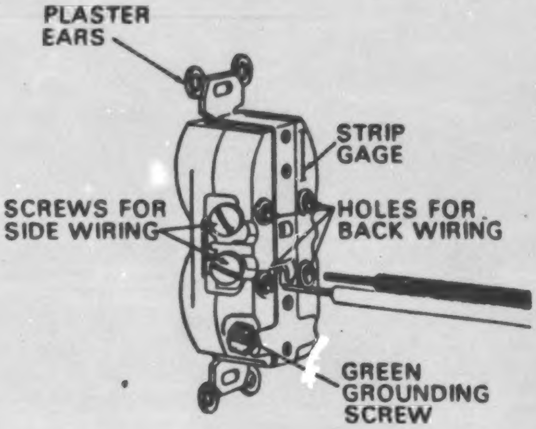

MOUNTING
SCREW
TILTED
BOX
RECEPTACLE
(STRAIGHT)
MOUNTING
SCREW

WIDE SLOT IN STRAP PERMITS ADJUSTMENT OF RECEPTACLE LEFT OR RIGHT AS REQUIRED FOR CORRECT POSITION.


COVER PLATE

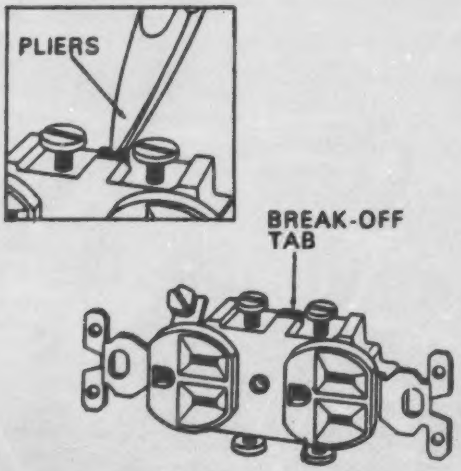
ATTACH COVER PLATE AFTER ALL PLASTERING AND PAINTING IS COMPLETED.

BACK-WIRED RECEPTACLES


PLASTER EARS
STRIP GAGE
SCREWS FOR SIDE WIRING
HOLES FOR BACK WIRING
GREEN GROUNDING SCREW

STRIP INSULATION AS REQUIRED AND INSERT WIRE INTO HOLES OF BACK-WIRED RECEPTACLE.

ALLOWING FOR MORE THAN ONE CIRCUIT

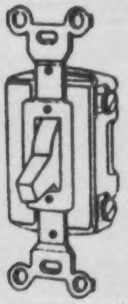

PLIERS
BREAK-OFF TAB

REMOVE THE CONNECTOR TAB TO WIRE THE DUPLEX RECEPTACLE WITH A SEPARATE CIRCUIT ON UPPER AND LOWER OUTLETS.

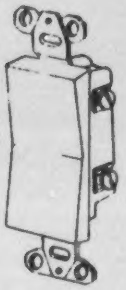
TRANSPARENCY IV-2-J

TYPES OF SWITCHES

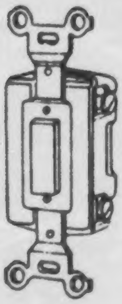
Toggle Switch

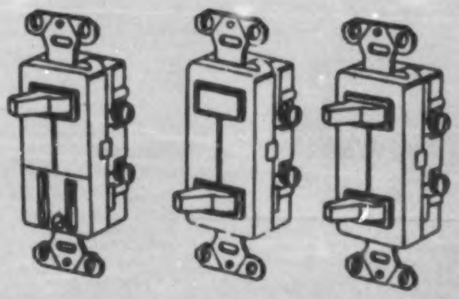


Rocker Switch
(DECORATOR STYLE)

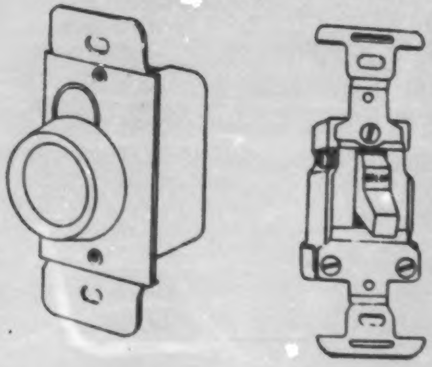


Push Button





EXAMPLES OF COMBINATION SWITCHES.



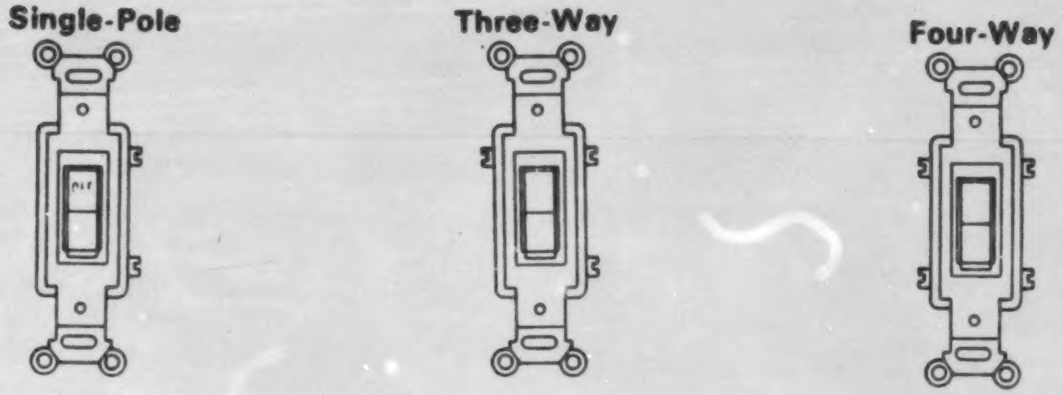
Rotary Dimmer

Time-Delay

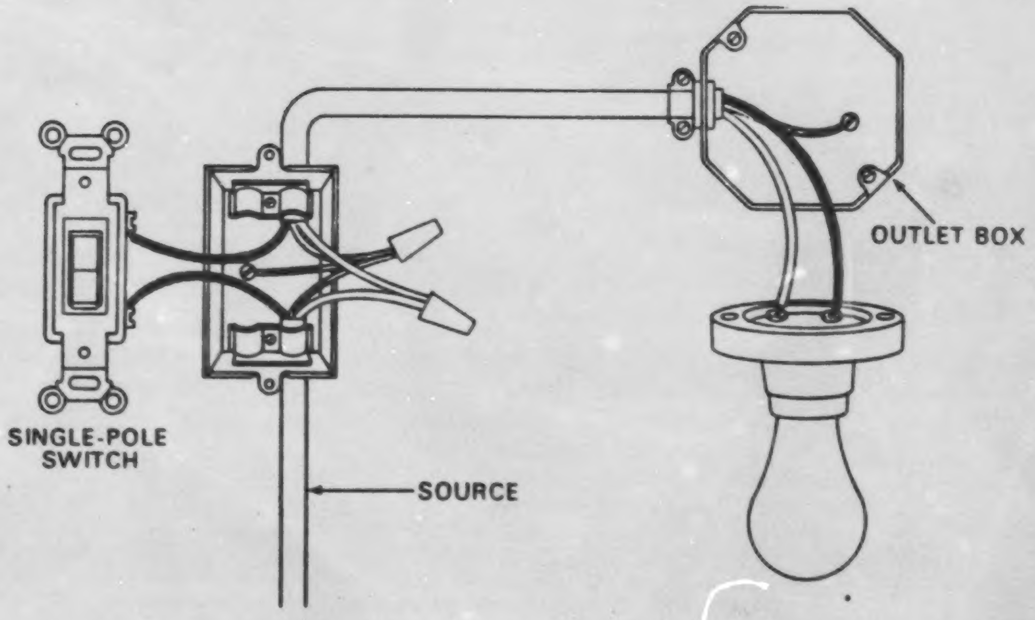
TIME-DELAY AND DIMMER SWITCHES

TRANSPARENCY IV-2-K

TYPES OF SWITCHES


Single-Pole
Three-Way
Four-Way

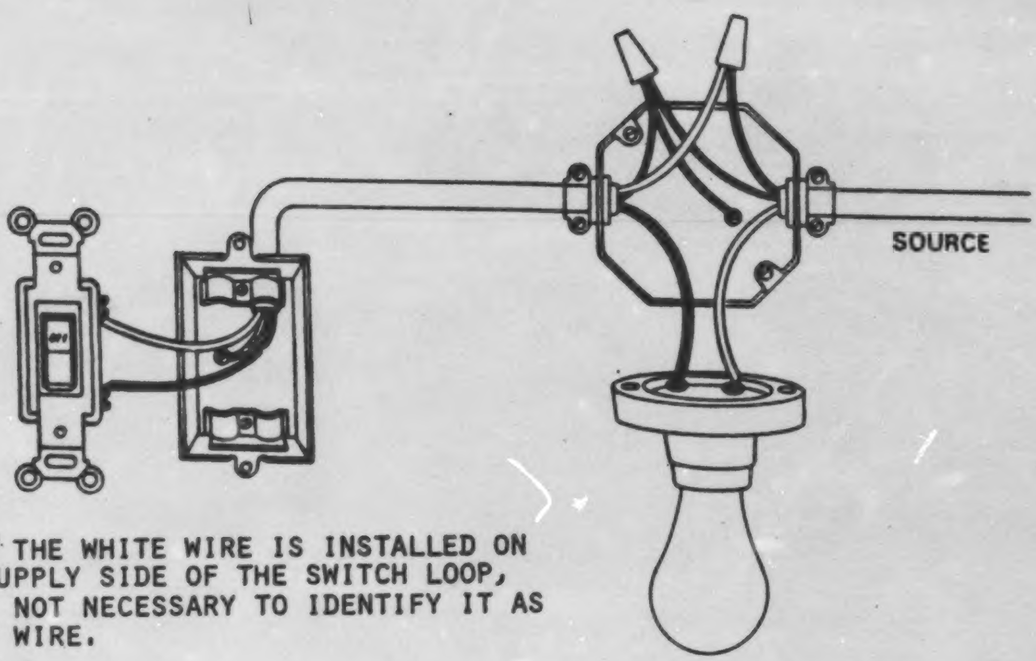
SINGLE-POLE, THREE-WAY AND FOUR-WAY SWITCHES.


OUTLET BOX
SINGLE-POLE SWITCH
SOURCE

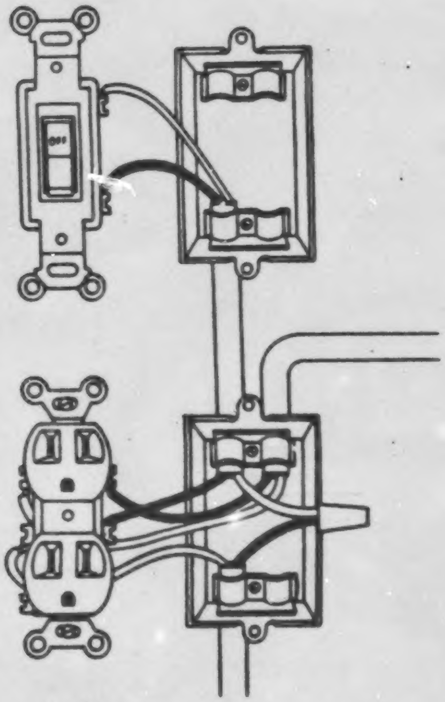
SINGLE-POLE SWITCH AND LIGHTING OUTLET WITH SWITCH-SOURCE WIRING.

TRANSPARENCY IV-2-L

SWITCH LOOP

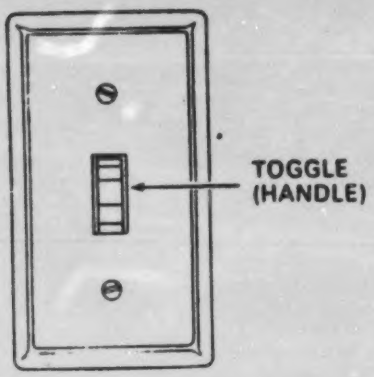


WHERE THE WHITE WIRE IS INSTALLED ON THE SUPPLY SIDE OF THE SWITCH LOOP, IT IS NOT NECESSARY TO IDENTIFY IT AS A HOT WIRE.

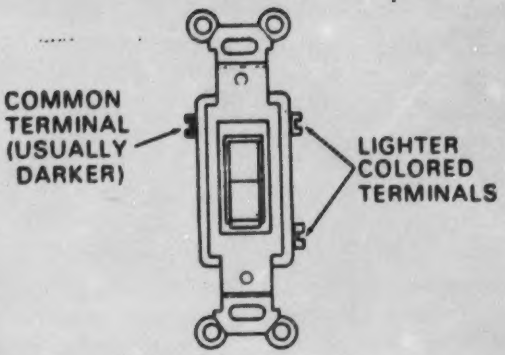


WIRING FOR A SWITCHED-DUPLEX RECEPTACLE.

IDENTIFYING THREE-WAY SWITCHES

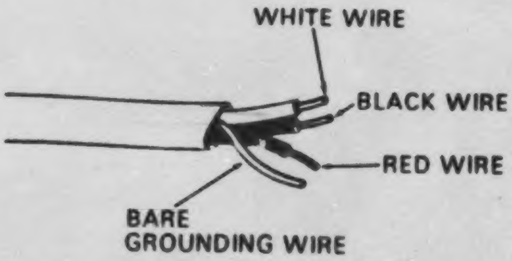

TOGGLE
(HANDLE)

THE TOGGLE ON A THREE-WAY SWITCH IS NOT MARKED TO INDICATE "ON-OFF."


COMMON
TERMINAL
(USUALLY
DARKER)
LIGHTER
COLORED
TERMINALS

THE COMMON TERMINAL SCREW ON A THREE-WAY SWITCH IS USUALLY, BUT NOT ALWAYS, DARKER THAN THE OTHER TWO TERMINALS.

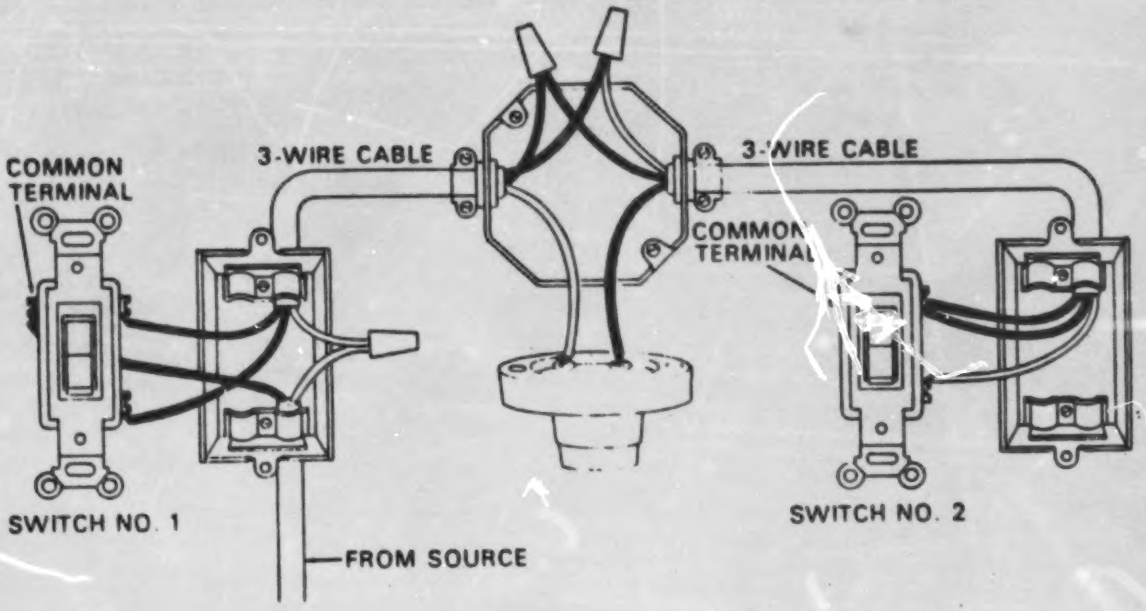
ONE TYPE OF ROMEX CABLE


WHITE WIRE
BLACK WIRE
RED WIRE
BARE
GROUNDING WIRE

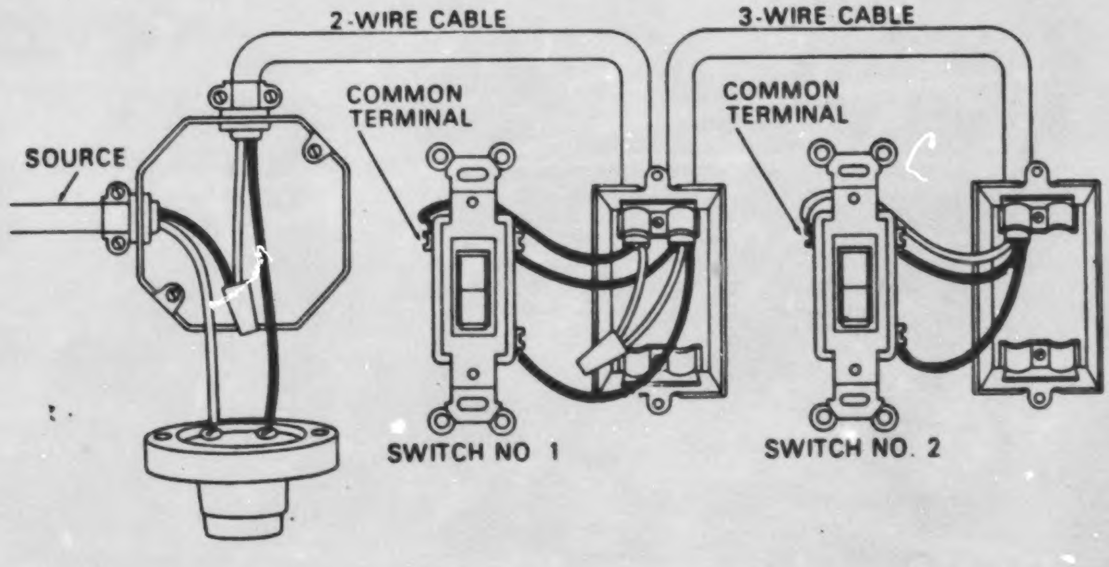
THREE-WIRE WITH GROUND CABLE.

TRANSPARENCY IV-2-N

WIRING FOR THREE-WAY SWITCH WITH LIGHTING OUTLET SOURCE

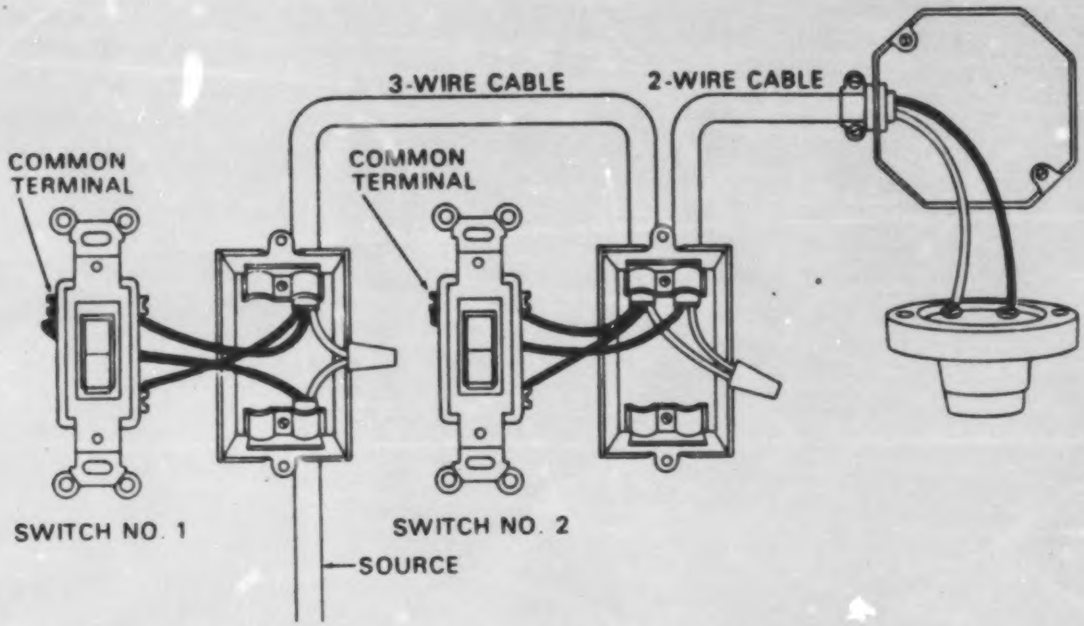

COMMON TERMINAL
3-WIRE CABLE
3-WIRE CABLE
COMMON TERMINAL
SWITCH NO. 1
FROM SOURCE
SWITCH NO. 2

WIRING FOR THREE-WAY SWITCHES WITH LIGHTING OUTLET BETWEEN SWITCHES

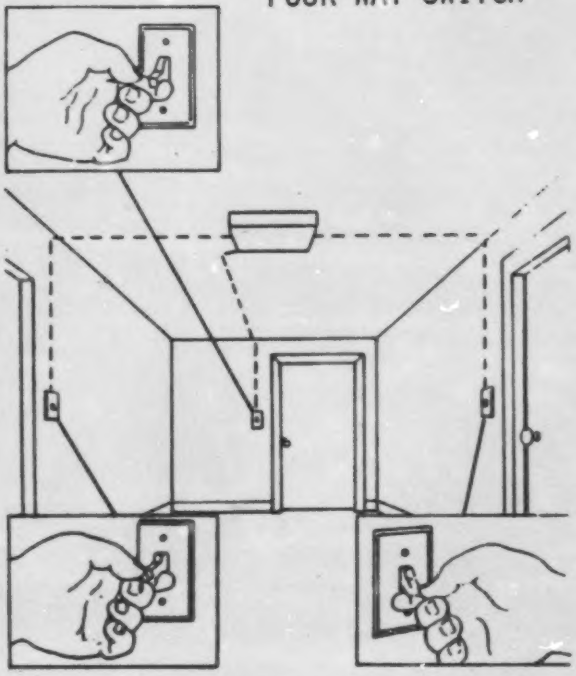

2-WIRE CABLE
3-WIRE CABLE
SOURCE
COMMON TERMINAL
COMMON TERMINAL
SWITCH NO 1
SWITCH NO. 2

TRANSPARENCY IV-2-0

WIRING FOR THREE-WAY SWITCHES WITH LIGHT AT END OF RUN USING SWITCH SOURCE


3-WIRE CABLE
2-WIRE CABLE
COMMON TERMINAL
COMMON TERMINAL
SWITCH NO. 1
SWITCH NO. 2
SOURCE

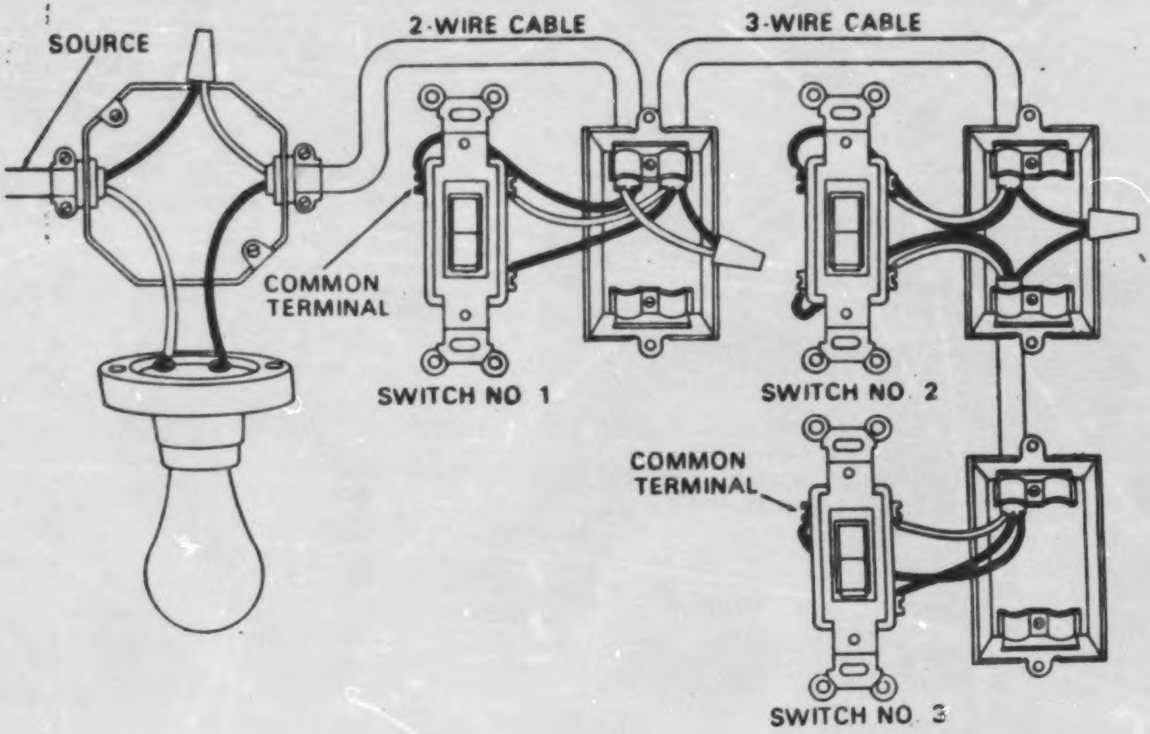
FOUR-WAY SWITCH



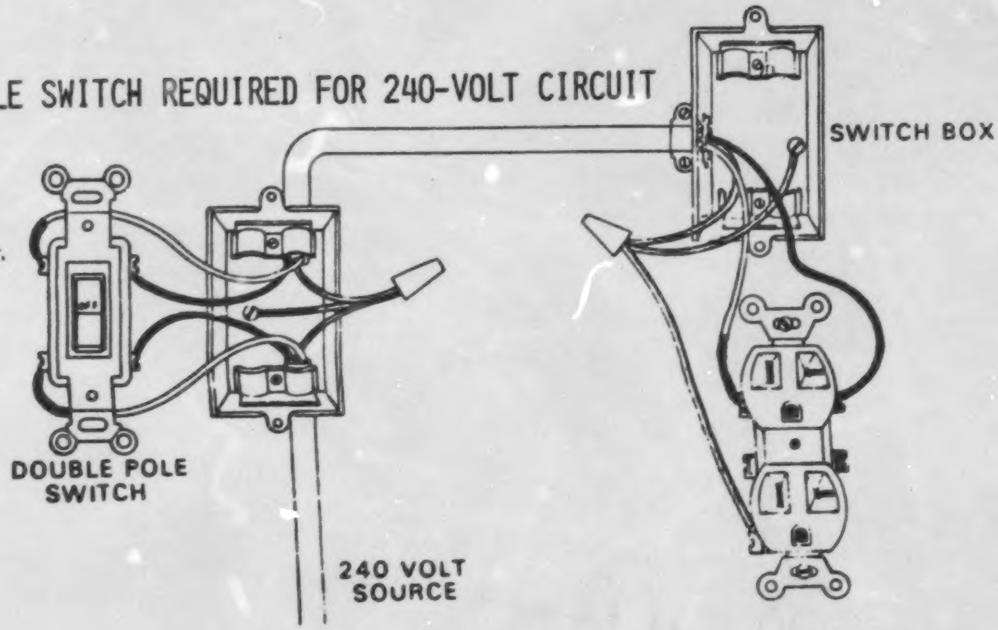
A CIRCUIT CONTAINING ONE FOUR-WAY SWITCH AND TWO THREE-WAY SWITCHES ALLOWS CONTROL FROM THREE LOCATIONS.

TRANSPARENCY IV-2-P

WIRING FOR FOUR-WAY SWITCH AND TWO THREE-WAY SWITCHES


SOURCE
2-WIRE CABLE
3-WIRE CABLE
COMMON TERMINAL
SWITCH NO 1
SWITCH NO. 2
COMMON TERMINAL
SWITCH NO. 3

DOUBLE-POLE SWITCH REQUIRED FOR 240-VOLT CIRCUIT


SWITCH BOX
DOUBLE POLE SWITCH
240 VOLT SOURCE

TRANSPARENCY IV-2-Q

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT V: Woodworking (Sophomore)

LESSON 1: Power Tool Safety and Operation

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Demonstrate safety and operational procedures for power woodworking tools.

2. Specific:

   a. State general power tool safety rules.
   b. List safety rules for each power tool.
   c. Identify and label parts of each power tool.
   d. Explain the purpose or use of each power tool.
   e. Describe the operation of each power tool.
   f.
   g.
   h.

B. Review of Teaching Materials

1. Phipps, L.S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

2. McCoy, V.L. and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

1. Collect pictures or posters of accidents resulting from violating safety rules for power woodworking tools.

2. Gather lumber samples that have been cut or altered by different types of power tools.

3. Make sure enough lumber is available to demonstrate the use of each tool.

4. Have all tools ready and operable for demonstration.

D. Materials required

1. Lumber -- The instructor will select the type to be used for each type of tool.

2. Pencils

II. Presentation of Lesson

A. Motivation

1. Show pictures of accidents that have happened because of violation of power tool safety rules.

2. Show students projects or pictures of items that can be built by using the various power woodworking tools.

3. Illustrate the time and cost savings that accrue by building or constructing things with the knowledge of how to use power tools properly.

B. Content Outline

1. General Power Tool Safety

   a. Wear eye protection at all times.

   b. Avoid wearing pants, shirts, or overalls that are too long. These may get caught in fast moving parts.

   c. Remove neckties, rings, matches, jewelry, and neck chains when working with power tools.

   d. Remove power plug or turn off power supply to machine when changing cutters, blades, or bits.

   e. Use guards on power equipment.

   f. Keep fingers away from moving cutting edges.

   g. Make all adjustments to tools with power off and machine at a dead stop.

   h. Always use sharp tools.

   i. Report strange noises and faulty equipment to the instructor.

   j. Select the proper tool for the job.

   k. Always ground power tools properly.

   l. Be sure switch is in "off" position before connecting the power plug.

2. Portable Power Saw

   a. Purpose -- Used primarily for straight cutting on lumber and plywood.

   b. Nomenclature -- (Transparency V-1-A)

      1) Motor

      2) Fixed guard

      3) Retractable guard

      4) Depth scale

      5) Angle scale

4) Tilting shoe or baseplate

5) Blade

6) Angle adjusting knob

7) Tilt lock knob

8) Insulated trigger switch

9) Depth lock knob

c. Safety

1) Make sure blade teeth are sharp and set correctly.

2) Always keep guard in place and blade adjusted for proper depth.

3) Make sure blade teeth are pointing in the direction of rotation.

4) Keep hands clear of cutting line.

5) Make all adjustments and blade changes with the power disconnected.

6) Do not stand in line with the cut. Always stand to the side. The blade can bind and kick the saw back out of the cut.

d. Operation

1) Adjust blade depth. Only 1/8 inch of the blade should show below the stock.

2) Place shoe on the stock with the blade in line with the layout line.

3) Turn on power and allow saw to come to full speed.

4) Guide the saw across the board firmly, adjusting speed of cut.

5) A crosscut and rip guide is available to make cutting more accurate.

6) Removing the blade

   a) Disconnect power.

   b) Remove arbor nut by applying pressure on a hex wrench in the direction of blade rotation and remove nut collar and blade.

   c) Reverse the process to put blade on.

3. Portable Electric Drill

   a. Purpose -- This tool is used for drilling, boring holes, and other uses when accessories are added.

   b. Nomenclature -- (Transparency V-1-B)

      1) Handle

      2) Trigger switch

      3) Geared key chuck

      4) Cord strain reliever

      5)

      6)

   c. Safety

      1) Be sure drill is securely clamped in the chuck.

      2) Make certain key has been removed.

      3) Never drill through cloth.

      4) Always clamp small pieces. Never attempt to hold them with your fingers when drilling.

      5) Use steady, even pressure when drilling.

      6) Always have the point of the drill away from the person when laying it down.

d. Operation

1) Use correct bit or accessory.

2) Make sure tool is sharp.

3) Apply just enough pressure to keep the drill cutting.

4) Hold tool at right-angles to the work when drilling a straight hole.

5) Installing a bit.

a) Open drill chuck jaws wide enough to accept the bit.

b) Insert bit shank in chuck as far as possible, then close jaws by hand.

c) Tighten chuck with key wrench. Insert in all three holes in succession to avoid slippage.

4. Saber Saw

a. Purpose -- This saw is used for straight or irregular cutting. It can be used on metal, wood, plastic, and other materials.

b. Nomenclature -- (Transparency V-1-C)

1) Guide knob

2) Blade screw

3) Tilting base

4) Brushes

5) Trigger switch

6) Blade

7)

8)

c. Safety

1) Select correct blade. Properly secure it in chuck.

2) Properly clamp material to be cut.

3) Do not force the cut.

4) Hold base down securely on the work when cutting.

5) Allow saw to come to a dead stop before setting down.

d. Operation

1) Set base of tool on the work. Start motor and allow saw to come to full speed. Move saw along slowly. This saw is held in one hand while the other hand can hold the work.

2) Plunge or internal cutting can be accomplished by marking out the area to be cut. Choose a spot inside the waste stock. Tip the saw forward with the shoe resting on the surface of the material and the top of the blade clear of the work. Turn on the power. After reaching full speed, slowly lower the back of the saw until the blade cuts through the material to the full depth.

3) The saw will also cut bevel cuts and curves for scroll work.

5. Portable Sander -- (Transparency V-1-D)

a. Purpose -- The sander provides a means of smoothing a surface for finishing.

b. Nomenclature

1) Front handle

2) Belt

3) Belt striker bar

4) Belt tracking adjustment

5) Trigger switch

6) D-handle

7)

8)

9)

c. Safety

1) Select correct grit for work being done.

2) Be sure belt is installed and tracking properly.

3) Keep hands away from abrasive surface.

4) Make certain there are no nicks or tears in the edge of a belt.

d. Operation

1) Hold machine with both hands. Turn the machine on and lower the tool to the surface. Do the sanding by moving the tool back and forth and, at the same time, slowly from one side to the other.

2) Make sure the proper sized belt is being used for the particular sander.

3) To install a belt, make sure the arrow on the inside of the belt points in the same direction as the arrow on the side of the sander. This should be in the direction of rotation. Adjust the tracking screw to align the belt on the pulleys. The belt should not be allowed to rub against the left side of the machine.

6. Circular Table Saw

a. Purpose -- This is versatile enough to allow the worker to cut stock to size and cut a variety of joints and bevels. These six basic blades are the crescent, hollow-ground, ripsaw, combination, easy-cut, and plywood.

b. Nomenclature --
(Transparency V-1-E)

1) Switch
2) Saw tilt scale
3) Saw tilt handwheel
4) Saw raising handwheel and lock knob
5) Sawdust clean-out
6) Miter gauge
7) Rip fence
8) Slot for miter gauge
9) Front graduated guide bar
10) Fence clamp handle
11) Push button switch
12) Fence micro-set knob
13)

c. Safety

1) Adjust saw blade so it protrudes just enough above the stock to cut completely through.

2) Keep fingers away from saw blade at all times during operation.

3) Never reach over a moving saw blade.

4) When crosscutting with a meter gauge, never use the rip fence for a stop unless a clearance block is used. Preferably do not use meter gauge and rip fence together.

5) Always use a push stick to push stock through that cannot be fed by hand.

6) Do not stand directly behind the blade.

7) When ripping, place jointed edge against the fence.

8) Remove all scraps from saw table using brush or stick. Never use fingers.

9) Remove rings, watches, or other items that might catch in the saw. Wear garments with short or tight fitting sleeves.

10) Be certain rip fence is tight.

11) When a helper assists, he should not pull the stock, but just support it.

12) Do not saw warped material on the table saw.

d. Operation

1) For crosscutting, use a hollow-ground or combination blade.

2) Use miter gauge for all crosscutting and remove rip fence.

3) Push stock through saw blade carefully, adjusting speed of cut.

4) To raise the blade to the proper position, hold the work against the side of the blade and raise the blade until it is about 1/8" above the stock.

5) To tilt the blade, locate the handle on the side of the machine. A pointer and scale in front indicate the degree of tilt. Adjust blade to desired angle and readjust the blade height.

6) The rip fence is used for ripping boards the proper width. It is usually placed to the right of the blade. To adjust the fence to the proper position, hold a rule at right angles to the fence and measure the desired distance from

the fence to one blade tooth bent toward the fence. Run a piece of waste stock through to determine if the measurement is correct. Continue with good stock after the necessary adjustments are made.

7) Adjust the miter gauge by simply setting it to the desired degree of cut, right or left.

7. Jointer

a. Purpose -- The jointer is commonly used for surfacing and edging boards. It can also be used for rabbets, bevels, chamfers, or tapers.

b. Nomenclature -- (Transparency V-1-F)

1) Fence

2) Rabbeting edge

3) Rear table adjusting wheel

4) Depth of cut scale

5) Tilt scale

6) Fence control handle

7) Front in-feed table

8) Rear out-feed table

9) Guard

10) Front table adjusting hand wheel

c. Safety

1) Always keep jointer knives sharp.

2) Make sure fence is tight.

3) Be sure guards are operating properly and never remove them for operation.

4) Keep left hand back from front end of board when feeding.

5) Always stand to the side of the jointer.

6) Cut with the grain, never against it.

7) Always use push stick or push block.

8) Do not use jointer for boards less than 12 inches long.

9) Do not use the jointer on the end grain of wood less than 12 inches wide.

10) Do not run cracked boards or boards with knots or nails through the jointer.

11) Allow machine to come to full speed before cutting.

12) Make several shallow cuts rather than one deep cut.

13) Keep table free of scraps and tools.

d. Operation

1) Check fence for squareness and table for depth of cut. Make a trial cut before making final cut.

2) Always check the board for warp and twist first. Put the concave surface down for the first cuts. For a twist, balance it on the high corners to take the first cuts.

3) Hold board firmly with the left hand and put the right hand on the push block. Apply equal pressure with both hands.

4) Move stock forward, keeping your left hand back of the cutterhead. When the board is half to two-thirds passed the cutterhead, move the left hand to the board over the outfeed table.

5) For edge planing, hold stock firmly against the infeed table and fence.

6) Rip the stock to width, allowing just enough extra stock to joint off the sawn edges.

8. Radial-arm Saw

a. Purpose -- It can be used for ripping, dadoing, grooving, and various combinations of these cuts. The advantage with this saw is that all cuts are visible to the operator.

b. Nomenclature -- (Transparency V-1-G)

1) Rip scale

2) Rip lock

3) Column

4) Yoke clamp handle

5) Space boards

6) Bevel scale

7) Bevel clamp handle

8) Bevel locating pin

9) Yoke

10) Dust spout

11) Radial arm

12) Miter scale

13) Yoke locating pin

14) Miter clamp handle

15) Elevating handle

16) Guide fence

17) Anti-kickback fingers

18)

19)

20)

c. Safety

1) Always keep safety guard and the anti-kickback device in position. When crosscutting, the anti-kickback device should be about 1/8 inch above the workpiece.

2) Hold stock firmly against the fence.

3) For crosscutting, pull the saw into the work.

4) Return saw to rear of table after each cut.

5) For ripping, make sure saw blade is rotating upwards toward you.

6) Keep hands and fingers away from the path of the saw.

7) Regulate rate of cutting by holding back the saw. If not, the saw will feed faster than it can cut, causing the motor to stall.

8) Do not put one piece of wood on top of another to cut at the same time.

9) Never attempt to cut stock away from the fence.

d. Operation

1) For crosscutting, the radial arm should be at zero on the miter scale and the blade at right angles to the table top. Adjust the blade so that the teeth are 1/16 inch below the surface of the work table. Adjust anti-kickback

fingers 1/8 inch from stock surface. Hold stock firmly against the fence and then turn on the power. Pull saw firmly but slowly through the work and return saw behind the guide fence.

2) For ripping, pull up on your locating pin and rotate the yoke 90 degrees clockwise until blade is parallel to fence. Move motor along radial arm until rip width is shown on the rip scale. Adjust anti-kickback device to 1/8 inch below work surface. Make sure the saw blade is rotating upwards toward you. Hold the work against the guide fence and feed it into the blade. Never feed work from the anti-kickback end.

9. Thickness Planer

a. Purpose -- This planer is used to smooth rough lumber and reduce the thickness of the wood.

b. Nomenclature -- (Transparency V-1-H)

1) Depth of cut gauge

2) Feed roll adjustments

3) Chip guard

4) Pressure bar adjustment

5) Table bed and upper wedge

6) Lower wedge

7) Variable speed feed roll control

8) Elevating handwheel

9)

10)

11)

c. Safety

1) Do not plane boards less than 12 inches long.

2) Never leave machines running.

3) Make sure wood is free from nails or loose knots.

4) Do not plane boards of different thicknesses at the same time. The thinner board may be kicked back.

5) Do not try to remove shavings while feeding wood through planer.

6) Make adjustments with the power off.

7) Stand to the side of the infeed table and out of line with the work.

8) Be careful with fingers and thumb in feeding short pieces. The rollers sometime tip short boards up a little as they go under, and the fingers may be pinched between the board and the table.

9) If a board stops at the end of the infeed table, do not try to push it with fingers. Jar it with a longer plank or shut down and lower the table.

d. Operation

1) Adjust table height by turning elevating hand wheel. Vary the amount of stock removed by looking at the depth of cut gauge.

2) Do not cut over 1/8 inch as a single pass.

3) Push stock into machine or infeed table. The machine will take the workpiece and the power feed rollers will take the piece through the machine.

10. Band Saw

   a. Purpose -- The band saw is used to saw curved or irregular shapes in wood. Straight cuts can be made with a rip fence or miter gauge. Curved cuts are made freehand.

   b. Nomenclature -- (Transparency V-1-I)

      1) Blade guard
      2) Blade guide
      3) Guide post
      4) Blade support lock screw
      5) Blade guide lock screw
      6) Blade
      7) Miter gauge groove
      8) Ball bearing blade support adjusting screw
      9) Adjusting screw for blade guides
      10) Table clamp
      11) Upper and lower wheel guards
      12) Ball bearing blade support
      13)

   c. Safety

      1) Avoid backing the blade out of a cut. If it is absolutely necessary, do so with the saw turned off.
      2) Use saw only when upper and lower wheel guards are in place and fastened.
      3) The blade guard should be adjusted to within ¼ inch of the work.

4) Check blade tension and alignment by turning wheels by hand.

5) Select proper width blade for the job.

6) Do not use cracked blades or blades without teeth.

7) Feed stock into the saw slowly.

d. Operation

1) Adjust blade tension and alignment.

2) Adjust table top to 90° or desired angle between 45° and 90°.

3) Stand directly behind the line of cut and feed the material with the right hand and guide it with the left.

4) Keep top guide close to the material.

5) By-pass sharp or square corners on waste side of the stock and come back after the first cut to saw out these places.

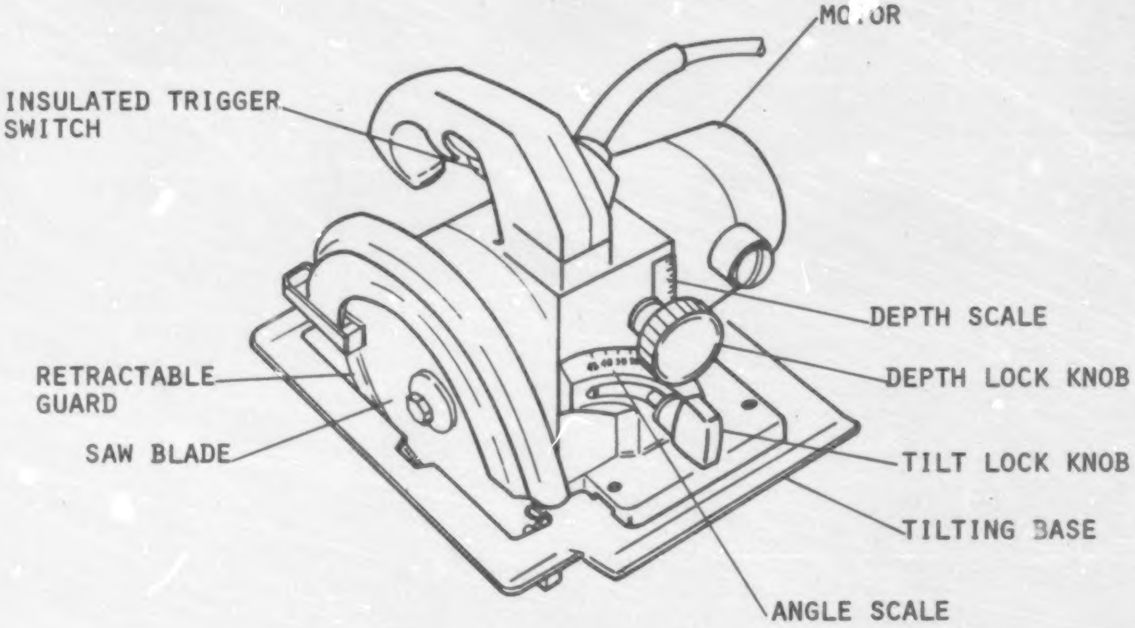
6) Circles, bevel cutting, cross-cutting, and ripping may be done with this saw.

C. Suggested Student Activities

1. Pass out unlabeled pictures of power wood-working tools to be labeled by students.

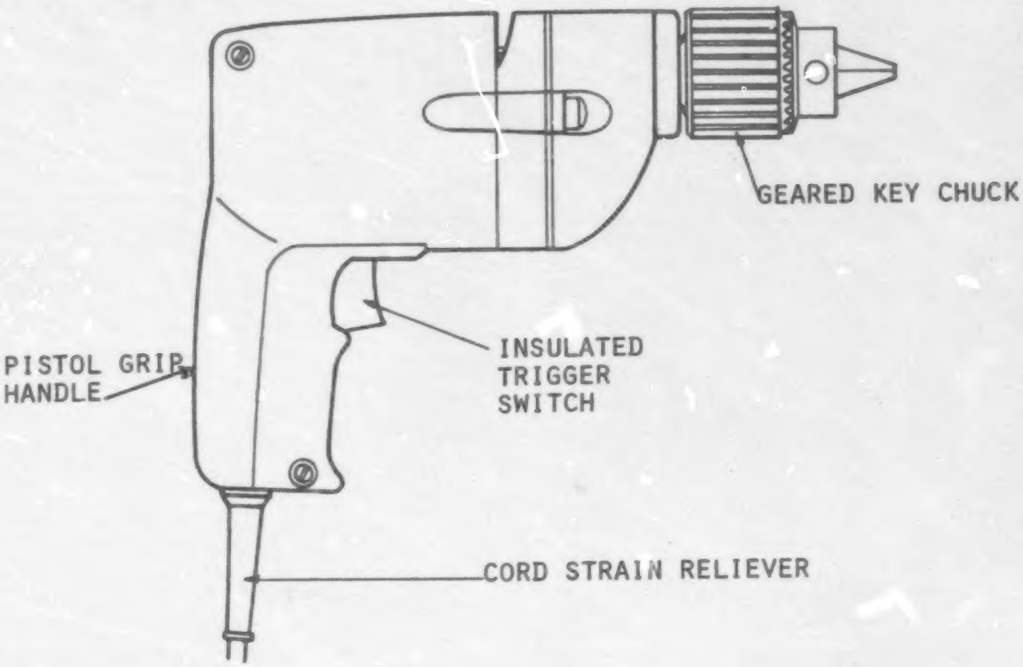
2. Students should practice and demonstrate proper use of each power tool.

PORTABLE POWER SAW NOMENCLATURE


MOTOR
INSULATED TRIGGER SWITCH
DEPTH SCALE
DEPTH LOCK KNOB
RETRACTABLE GUARD
SAW BLADE
TILT LOCK KNOB
TILTING BASE
ANGLE SCALE

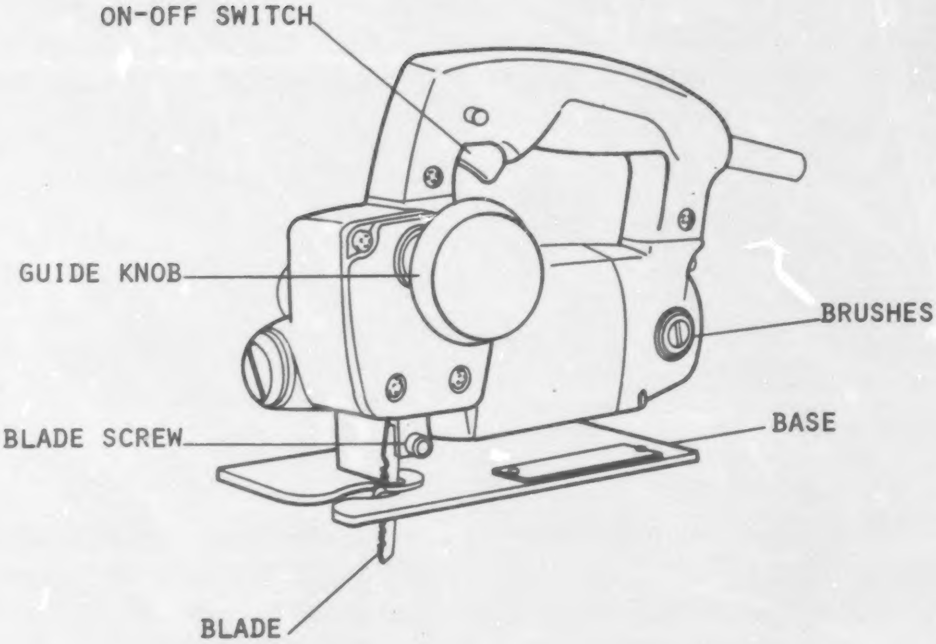
TRANSPARENCY V-1-A

PORTABLE ELECTRIC HAND DRILL NOMENCLATURE


GEARED KEY CHUCK
INSULATED TRIGGER SWITCH
PISTOL GRIP HANDLE
CORD STRAIN RELIEVER

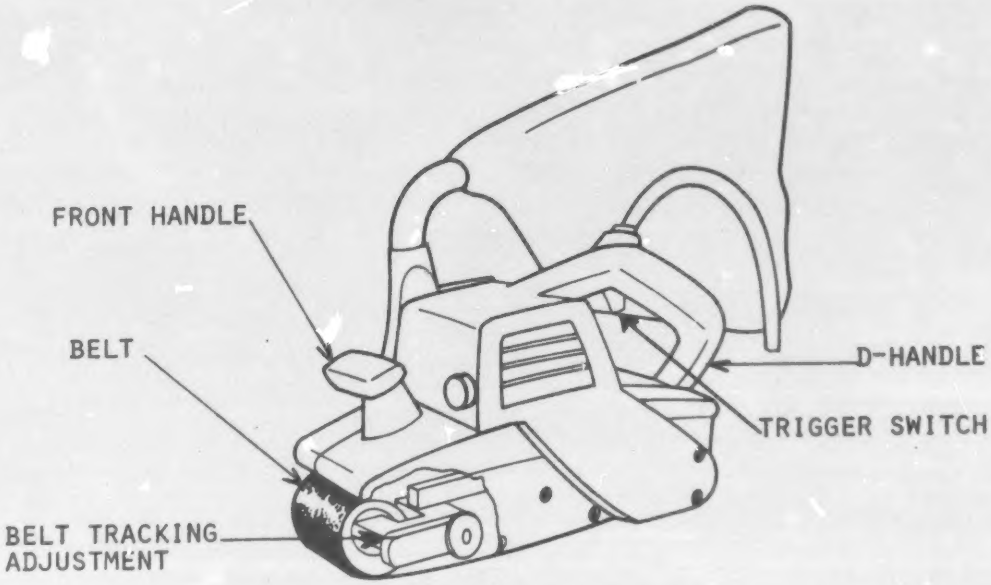
TRANSPARENCY V-1-B

PORTABLE SABER SAW NOMENCLATURE


ON-OFF SWITCH
GUIDE KNOB
BRUSHES
BASE
BLADE SCREW
BLADE

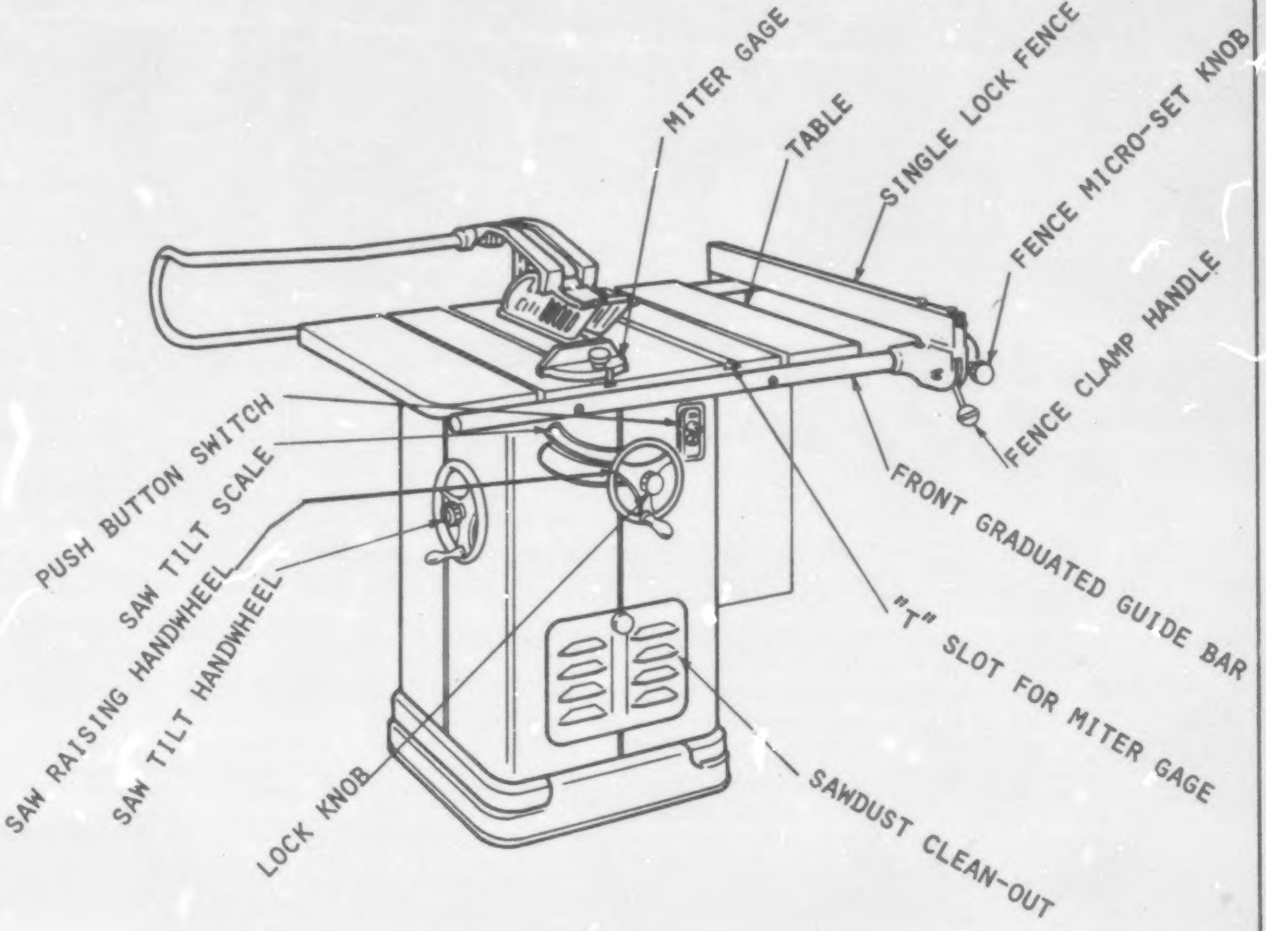
TRANSPARENCY V-1-C.

PORTABLE POWER SANDER NOMENCLATURE


FRONT HANDLE
BELT
BELT TRACKING ADJUSTMENT
D-HANDLE
TRIGGER SWITCH

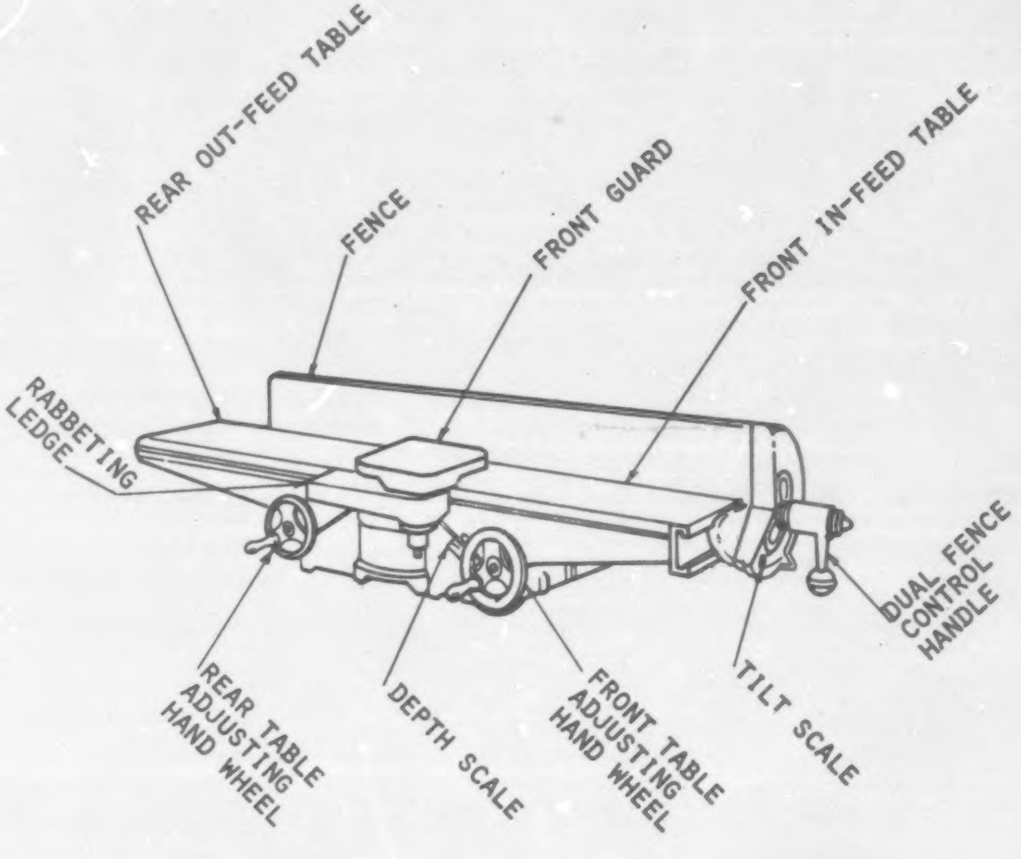
TRANSPARENCY V-1-D

CIRCULAR TABLE SAW NOMENCLATURE


MITER GAGE
TABLE
SINGLE LOCK FENCE
FENCE MICRO-SET KNOB
FENCE CLAMP HANDLE
FRONT GRADUATED GUIDE BAR
"T" SLOT FOR MITER GAGE
SAWDUST CLEAN-OUT
LOCK KNOB
SAW TILT HANDWHEEL
SAW RAISING HANDWHEEL
SAW TILT SCALE
PUSH BUTTON SWITCH

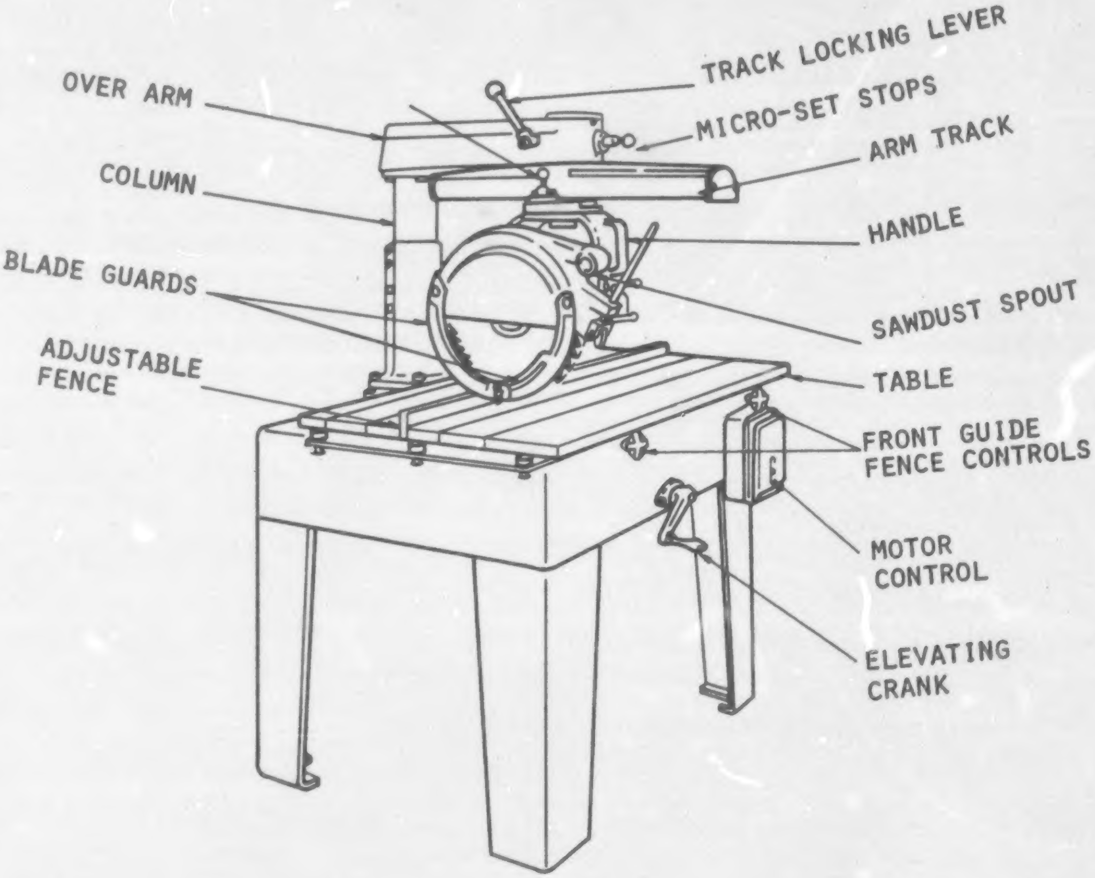
TRANSPARENCY V-1-E

JOINTER NOMENCLATURE

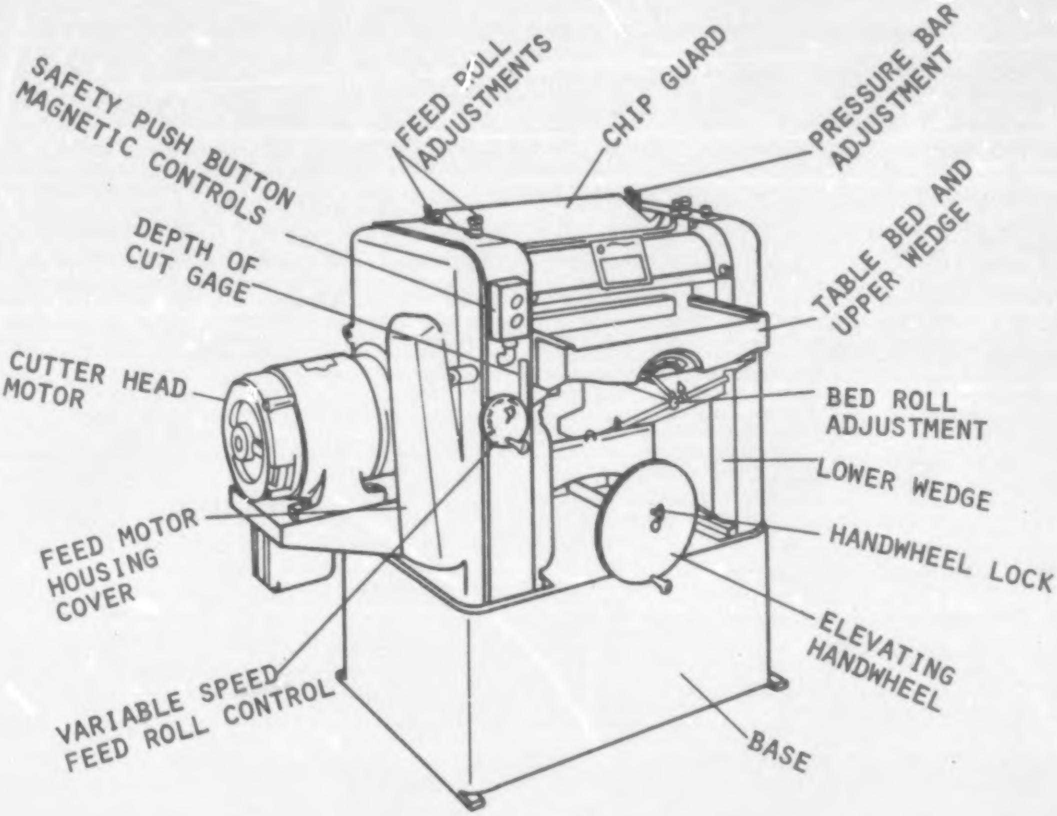

REAR OUT-FEED TABLE
FENCE
FRONT GUARD
FRONT IN-FEED TABLE
RABBETING LEDGE
DUAL FENCE CONTROL HANDLE
REAR TABLE ADJUSTING HAND WHEEL
DEPTH SCALE
FRONT TABLE ADJUSTING HAND WHEEL
TILT SCALE

TRANSPARENCY V-1-F

RADIAL ARM SAW NOMENCLATURE

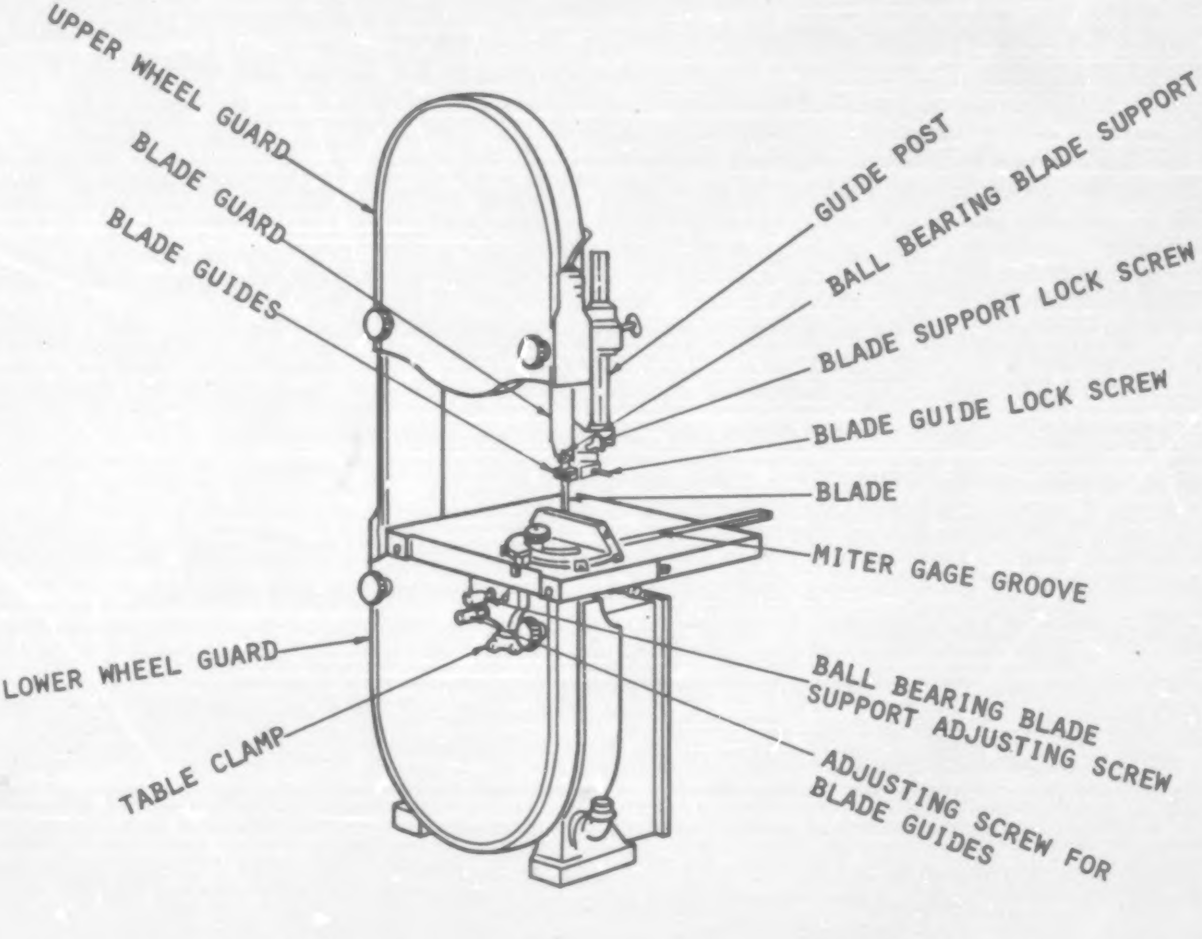

TRACK LOCKING LEVER
OVER ARM
MICRO-SET STOPS
ARM TRACK
COLUMN
HANDLE
BLADE GUARDS
SAWDUST SPOUT
ADJUSTABLE FENCE
TABLE
FRONT GUIDE FENCE CONTROLS
MOTOR CONTROL
ELEVATING CRANK

THICKNESS PLANER NOMENCLATURE


SAFETY PUSH BUTTON MAGNETIC CONTROLS
FEED ROLL ADJUSTMENTS
CHIP GUARD
PRESSURE BAR ADJUSTMENT
DEPTH OF CUT GAGE
TABLE BED AND UPPER WEDGE
CUTTER HEAD MOTOR
BED ROLL ADJUSTMENT
LOWER WEDGE
FEED MOTOR HOUSING COVER
HANDWHEEL LOCK
ELEVATING HANDWHEEL
VARIABLE SPEED FEED ROLL CONTROL
BASE

TRANSPARENCY V-1-H

POWER BAND SAW NOMENCLATURE


UPPER WHEEL GUARD
BLADE GUARD
BLADE GUIDES
GUIDE POST
BALL BEARING BLADE SUPPORT
BLADE SUPPORT LOCK SCREW
BLADE GUIDE LOCK SCREW
BLADE
MITER GAGE GROOVE
LOWER WHEEL GUARD
TABLE CLAMP
BALL BEARING BLADE SUPPORT ADJUSTING SCREW
ADJUSTING SCREW FOR BLADE GUIDES

a

TRANSPARENCY V-1-I

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT V: Woodwork (Sophomore)

LESSON 2: Project Planning

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Plan a project to the point of beginning to build the object.

2. Specific:

a. List the eight-step procedure for planning a shop project.
b. List the items to be considered when selecting a project.
c. State four reasons for drawing a working plan of the project.
d. List three items to consider in selecting materials for the project.
e. Define a bill of materials.
f. Name the items of information listed on a bill of materials.
g. Define board feet.
h. Calculate board feet.
i. Explain the method for determining lumber cost.
j. Describe the method for pricing shingles.
k. Demonstrate the method for completing a bill of materials.
l.

m.

n.

B. Review of Teaching Materials

1. Phipps, L.J. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

2. McCoy, V.L. and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

1. Collect plans that students have completed in previous years.

2. Copy the transparency of the form for the project bill of materials. This will be used by the students for exercises.

II. Presentation of Lesson

A. Motivation

1. Give one student a plan and bill of materials for a project. Give another student nothing but a directive to build a project. The student getting nothing will begin to ask such questions as:

What am I to build?
What materials should I use?
How big should it be?
When do you want it?

Use this opportunity to explain the necessity of planning, sketching, and computing a bill of materials.

2. Show plans and bills of materials from previous classes.

B. Content

1. Introduction

Prior planning is essential for the successful completion of any project. Lack of planning results in indecision, poor workmanship, and less than a desirable product. Therefore, prior to beginning of any project, a sequential process needs to be followed to include the necessary steps for decision making before construction starts. This process includes the following steps:

a. Determine the desired project.

b. Draw plan for project to include dimensions (See Unit II, Lesson 4.)

c. Estimate the time it will take for project completion. Be certain there is enough time for the construction of the project.

d. Select appropriate materials, fasteners, hardware, etc.

e. Determine cost of project by calculating a bill of materials based upon the drawing or sketch of the project.

f. Obtain appropriate materials, fasteners, hardware, etc.

g. Determine and obtain necessary tools for project completion.

h. Plan a sequence of steps to follow in order to avoid confusion and unnecessary problems.

i. Begin the project.

2. Determine desired project -- Several items to be considered in selecting a project are:

a. Personal choice,

b. Usefulness of project,

c. Need for the project,

   d. **Affordability, and**

   e. **Personal skill level.**

3. **Draw a sketch or plan of the project (See Unit II, Lesson 4) -- It is important to make a drawing of the project in order to:**

   a. See the basic size and shape of the project,

   b. Make necessary changes in the design of the project,

   c. Determine the amount of materials needed to build the project. This will also aid in calculating a bill of materials used in estimating project cost, and

   d. Plan and determine the dimensions from which to construct the actual project. This will minimize needless work and errors.

4. Estimate the time it will take for project completion. Be certain there is enough time for construction of the project.

5. Select appropriate materials, fasteners, hardware, etc. -- At this point in the planning procedure, one must decide exactly what kinds of materials to use when constructing the project. This would include choices such as:

   a. Wood or metal,

   b. T-hinge or flat hinge,

   c. Glue or nails,

   d. Glue or screws,

   e. Paint or stain, and

   f. Fine sandpaper or extra fine sandpaper.

   Selection of these materials is extremely important. When selecting these materials, the following items should be considered:

Project	Material Used
a. Economy	a. Cost
b. Permanency and strength	b. Durability and longevity
c. Use of project	c. Grade and quality
d. Location of project (interior or exterior)	d. Weathering characteristics of materials
e. Exterior finish for the project	e. Aesthetic nature of materials

6. Determine cost by calculating a bill of materials.

   a. A bill of materials is a list of the amount, size, and kind of each item needed for a particular job or project. A person must study the drawing or sketch of the project in detail when preparing a bill of materials.

   b. A bill of material contains: (see Transparency V-2-A)

      1) Name of individual,

      2) Date started and completed,

      3) Name of the project,

      4) Number of pieces,

      5) Kind of material,

      6) Name of each piece,

      7) Dimensions of each piece,

      8) Number of board feet,

      9) Cost/unit, and

      10) Total cost.

   c. Unit of measure in selling lumber:

      1) The unit of measure in lumber is a board foot.

2) Lumber is generally priced on the basis of a 1,000 board feet. Some finish lumber and molding is priced by the running foot.

3) A board is the equivalent of a piece of lumber one inch thick, 12 inches wide, and 12 inches long or 144 cubic inches.

4) To calculate the number of board feet, multiply the thickness in inches times the width in inches times the length in feet and divide by 12. For example, a board 1 inch thick, 6 inches wide and 16 feet long equals 8 board feet.

$$\frac{1 \text{ inch} \times 6 \text{ inch} \times 16 \text{ feet}}{12} = 8 \text{ board feet}$$

5) If there are several pieces of lumber the same size, calculate the total board feet by multiplying the number of pieces by the thickness in inches times the length in feet and divide the product by 12.

For example, 12 pieces 1 inch thick, 4 inches wide, and 12 feet long would be figured as follows:

$$\frac{12 \times 1 \text{ inch} \times 4 \text{ inches} \times 12 \text{ feet}}{12} = 48 \text{ board feet}$$

6) A running foot refers to the foot length of lumber regardless of thickness or width.

d. Determining cost of lumber:

1) Calculate the number of board feet, multiply this number by the cost per thousand board feet, and point off three places. For example, the value of three beams 6 inches by 8 inches by 20 feet long at $60.00 per 1,000 board feet would be:

$$\frac{3 \text{ pieces} \times 6 \text{ inches} \times 8 \text{ inches} \times 20 \text{ feet}}{12} = 240 \text{ board feet}$$

240 board feet x $60.00/1000 board feet = $14.40.

2) Some items are not priced by the board foot. Some are priced by the running foot or by the sheet with such items as plywood, sheetrock, or molding. The prices for these items should be calculated accordingly.

3) Roofing shingles are sold by the square. A square will cover 100 square feet of roof area. Calculate the total number of square feet of roof area and divide by 100 to determine the number of squares of shingles needed. Multiply this figure by the cost per square for the total cost.

e. Method for writing dimensions:

1) A bill of materials should be written so that it can be easily understood.

2) Several items of information are necessary on a bill of materials: (Transparency V-2-A)

(a) Number of items,

(b) Dimension, size, weight, etc.,

(c) Kind, quality, grade, or type,

(d) Cost per 1,000 board feet,

(e) Unit cost,

(f) Place of purchase, and

(g) Total cost.

3) One method to write the information is shown on Transparency V-2-B.

7. Secure appropriate materials, fasteners, hardware, etc.

8. Determine and obtain necessary tools for project completion:

   a. Use hand tools or power tools.
   b. Locate tools in shop and make arrangements for check out of tools.
   c. Make sure the instructor has determined that the student can operate the tool or machine safely.

9. Plan a sequence of steps to follow to avoid confusion and unnecessary problems.

10. Begin the project.

C. Suggested Student Activities

1. Assign each student a bill of materials to complete. Have students determine a total cost estimate. This problem will be given at the discretion of the instructor.

2. The students are to draw a working plan of a proposed project.

3. Students will compute a bill of materials for the project that they will complete. They may use the form attached.

4.

A PROJECT BILL OF MATERIAL

NAME: ______________________ PROJECT: ______________________

CLASS ____________ DATE STARTED ______________ FINISHED __________

Items	No.	Dimension, Size Weight, etc.	Kind, Quality Grade or Type	Unit Cost	Place of Purchase	Total

Sub Total ____________

Grand Total

Instructor Approval ______________________ ____________

Parent or Guardian Approval ________________

TRANSPARENCY V-2-A

A PROJECT BILL OF MATERIAL

NAME: ____________________ PROJECT: ____________________

CLASS __________ DATE STARTED ____________ FINISHED ________

Items	No.	Dimension, Size Weight, etc.	Kind, Quality Grade or Type	Unit Cost	Place of Purchase	Total
	3	2"x4"x]2	#2 Yellow Pine	$ 2.00 @ $250.00/ 1,000 bd. ft.	Lumber Co.	$ 6.00
	8	4'x8'	A/C Plywood	30.00		240.00
	400'		Cove Molding	.25		100.00
						$346.00

Sub Total ____________

Grand Total

Instructor Approval ____________________ ____________

Parent or Guardian Approval ____________________

TRANSPARENCY V-2-B

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT V: Woodworking (Sophomore)

LESSON 3: Cutting Rafters

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Layout and cut a common rafter.

2. Specific:

   a. Define new terms.
   b. Explain how a rafter square is used in cutting rafters.
   c. Calculate the pitch of a roof.
   d. Demonstrate the unit, length, and step-off method of laying out a common rafter.
   e. State the importance of the cut of a roof.
   f. Demonstrate the procedure for rafter ridge allowance and rafter overhang.
   g. Demonstrate cutting a bird's mouth in a common rafter.
   h.
   i.
   j.

B. Review of Teaching Materials

1. Phipps, L.J. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

2. Mc Coy, V.L. and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

1. Layout and cut a common rafter. Label the parts of the rafter for purposes of identification.

2. Secure an adequate amount of lumber for practice in cutting rafters.

3. Obtain poster board for student activity.

4. Duplicate information sheets and transparencies for student use.

D. Materials Required

1. Proper tools

    a. Framing square

    b. Pencil

    c. Handsaw

2. Lumber -- 2x4 pine

3. Poster board

II. Presentation of Lesson

A. Motivation

1. Discuss the savings in money that can accrue when people are able to build their own structures rather than hire someone.

2. Show pictures of both poorly constructed and well-constructed roof structures on farm buildings. Compare the two. Emphasize the benefits of learning the proper method of rafter cutting.

3. Make a "rafter cutting" award. At the end of the instruction on this lesson, conduct a rafter cutting contest. The individual doing the best job will win this award. It can be presented at a chapter meeting or at the annual FFA banquet.

B. Content Outline

1. New Terms -- Transparency V-3-A

   a. Rafter -- The sloping structural member of the roof framework. This provides support for the roofing and is usually spaced 16 inches or 24 inches apart.

   b. Plate -- This is the base on which the lower end of the rafter rests. The plate rests across the top of the studding or wall.

   c. Span -- The distance between the outside edge of the double plates. It is measured at right angles to the ridge board.

   d. Run -- One-half the span distance.

   e. Unit of run -- This is equal to 12 inches or one foot.

   f. Rise -- The vertical distance from the top of the double plate to the upper end of the measuring line.

   g. Measuring line -- An imaginary line running lengthwise from the outside wall to the ridge.

   h. Unit rise -- This is the number of inches that a roof rises for each foot of run.

   i. Pitch -- The angle that the roof surface makes with a horizontal plane. This is also called the slope. It is the ratio of rise to the span.

   j. Slope -- The incline of a roof. Slope is the inches of vertical rise in 12 inches of horizontal run.

   k. Plumb and level lines -- When the rafter is in proper position, any vertical line is called the plumb line. Any line that is level when the rafter is in proper position is called the level line.

l. Ridge board -- This is the horizontal piece that connects the upper ends of the rafters.

m. Rafter tail -- This is the portion of the rafter that extends beyond the wall of the building. It forms the overhang or eave.

n. Common rafter -- A rafter that extends from the top plate to the ridge board at 90° to both.

2. Calculation of the pitch of a roof

   a. The pitch is actually how much slope a roof exhibits. It is the ratio of the rise to the span (Transparency V-3-B and V-3-C).

   b. Calculation:

   $$\text{Pitch equals } \frac{\text{rise}}{\text{span}} \quad \text{or} \quad \frac{\text{rise}}{2 \times \text{run}}$$

   Example:

   A roof having a rise of 6 feet and a span of 24 feet would have a ¼ pitch.

   $$\frac{\text{6 foot (rise)}}{\text{24 foot (span)}} = \text{¼ pitch}$$

   c. Common roof pitches are 1/4, 1/2, and 1/3. Transparency V-3-D

   d. Transparency V-3-E -- The cut of roof is determined from the calculation of pitch. This may be referred to as "8 and 12" or "6 and 12." The first number refers to the rise per foot of run and the second number refers to the unit of run which is always 12 inches. The first number comes from the calculation of pitch. For example, if a roof has ¼ pitch, the cut of the roof would be "6 and 12." These numbers are then used on the framing square to layout a rafter. The first number will be used on the tongue of the square while the second number (12) will always be located on the body. As an example, for a roof with a cut of "8 and 12," one would find 8 inches on the

tongue and 12 inches on the body 180
of the square in order to properly lay-out a rafter with the step-off method.

3. Use of Rafter (Framing) Square

   a. A rafter square is a large steel square consisting of a blade, or body, and a tongue. The body is usually 24 inches long and the tongue is 16 inches.

   b. The flat sides of the blade and tongue are graduated in inches and fractions of an inch.

   c. The square contains tables and information useful in simplifying many woodworking tasks.

   d. The rafter square is used in both the unit length and step-off method of laying out rafters.

   e. The run is scaled on the blade or body of the square and the rise is scaled on the tongue.

   f. Transparency V-3-F -- If the rafter is placed in a sloping position as it would be on a roof, and the square is placed so the blade is along the line of the plate and the tongue is in line with the ridge, a line can be drawn along the blade and tongue that is horizontal (plumb) and vertical (level), respectively.

   g. Transparency V-3-G -- The usual method is to lay off 12 inches along the blade, representing one unit of run, and the number of inches on the tongue depends on the slope of the roof, such as 6 inches when the pitch is ¼.

   h. The top of the rafter or center line is used as a work line. The square is held as shown in Transparency V-3-G with the figures for run and rise on the work line.

   i. Transparency V-3-G -- A line scribed along the blade will be parallel to the seat or horizontal cut, and a line scribed along the tongue will be plumb when the rafter is in position.

4. Laying out Common Rafters

   a. Transparency V-3-H -- The rafters are the skeleton of the roof and must be properly cut and fitted to support the roof weight. The top of the rafter rests against the ridge board and is called a plumb cut. The bottom of the rafter rests on the plate and is called the seat cut.

   b. For a plumb cut, align the unit run (12 inches) on the body of the square with the edge of the rafter. The unit rise on the tongue of the square, which corresponds to the slope of the roof, is aligned on the same edge of the rafter. The plumb line is taken down on the edge of the tongue. A level line or seat cut is made with the square in the same position except the line is drawn along the body of the framing square.

   c. Transparency V-3-I -- The theoretical length of a common rafter is the shortest distance between the outer edge of the plate and a point where the measuring line of the rafter contacts the ridge line or ridge board. This length is computed along the measuring line considered to be in the center of the rafter.

5. Methods of rafter layout

   a. Unit length method (Transparency V-3-J)

      1) The unit length is the hypotenuse of a right triangle with the unit run (12 inches) as the base and the unit rise (rise in inches per foot of run) as the altitude.

      2) The unit length table is formed on the side of the body of the framing square. The inch markings along the top of the table represent unit rise. The top line of the

table reads "Length Common Rafters per Foot Run."

3) For example, follow across the top line to the figure under six (for a unit rise of 6 inches). Under that figure is the number 13.42. This is the unit length of a roof triangle or rafter with a unit rise of 6 inches and a unit run of 12 inches.

4) Find the total length of a rafter with a unit rise of 5 inches, a span of 6 feet and a run of 3 feet.

5) The total length is determined by multiplying the unit length times the total run.

b. The Step-off Method -- Transparency V-3-K

1) Place square on the rafter with the tongue on the plumb cut.

2) Step off the cut of the roof (Ex. 6 inches on tongue and 12 inches on the body) on the rafter as many times as there are feet in the total run.

3) Transparency V-3-L -- Many times the run will not come out in even feet. For example, the run might be 3 feet 4 inches. The extra 4 inches is taken care of in the same manner as the full foot run. When the square is placed in the last full step position, place a plumb line along the tongue of the square. Move the blade of the square over until the 4 inch mark lines up with the line just made. Then line up blade and tongue on the rafter just as if a full step is to be made. The plumb line can now be made. This will give this rafter the total 9 feet 4 inches length.

6. Cutting the Common Rafter 183

a. Rafter ridge board allowance -- Transparency V-3-M

1) Theoretical length does not take into account thickness of ridge board or overhang.

2) To allow for ridge board, deduct one-half the thickness of the ridge board from the ridge end of the rafter. If the ridge board is 1½ inches thick, one-half of this would be 3/4 inches. This amount would be taken off the theoretical length.

b. Common rafter overhang -- Transparency V-3-N

1) The rafter overhang extends beyond the wall of the structure to form the eave. The overhanging part of the rafter is called the tail.

2) The length of the rafter tail may be calculated just like a small rafter. Any of the methods previously mentioned to find rafter length can be used to find tail length. For example, the run of an overhang is 2 feet and the unit rise per foot of run off the roof is 6 inches. Go to the rafter table on the framing square and find the length of common rafter with a unit rise of 6 inches. That length is 13.42 inches. Multiply the total number of runs (2) by the unit length to find the length of rafter tail. Inches per unit of run x units of run = rafter tail length

Example: 13.42 (inches per unit of run) x 2 (units of run) = 26.84"

In this case, the rafter tail length will be 26.84 inches or 26 27/32 inches.

c. Bird's mouth

1) A rafter with an overhang has a notch in it called a bird's mouth. The bird's mouth allows the rafter to sit level and plumb in the top plate.

2) Transparency V-3-O -- The plumb cut of the bird's mouth which contacts the side of the plate is called the heel cut. The level cut that contacts the top of the plate is called the seat cut.

3) The size of the bird's mouth is usually referred to as the depth of heel.

4) To layout the bird's mouth, measure off the depth of heel on the heel plumb line, set the square, and draw the seat line along the blade. The depth of the heel is no more than half the thickness of the rafter.

d. Rafter pattern -- (Transparency V-3-P)

1) After carefully laying out and cutting a rafter, use it as a pattern for cutting a second rafter.

2) Try the two rafters with the ridge board, or material of the same size, to see how the heel cut and top cut fit.

3) If the fit is good, use one of these rafters as a pattern to cut out all others needed.

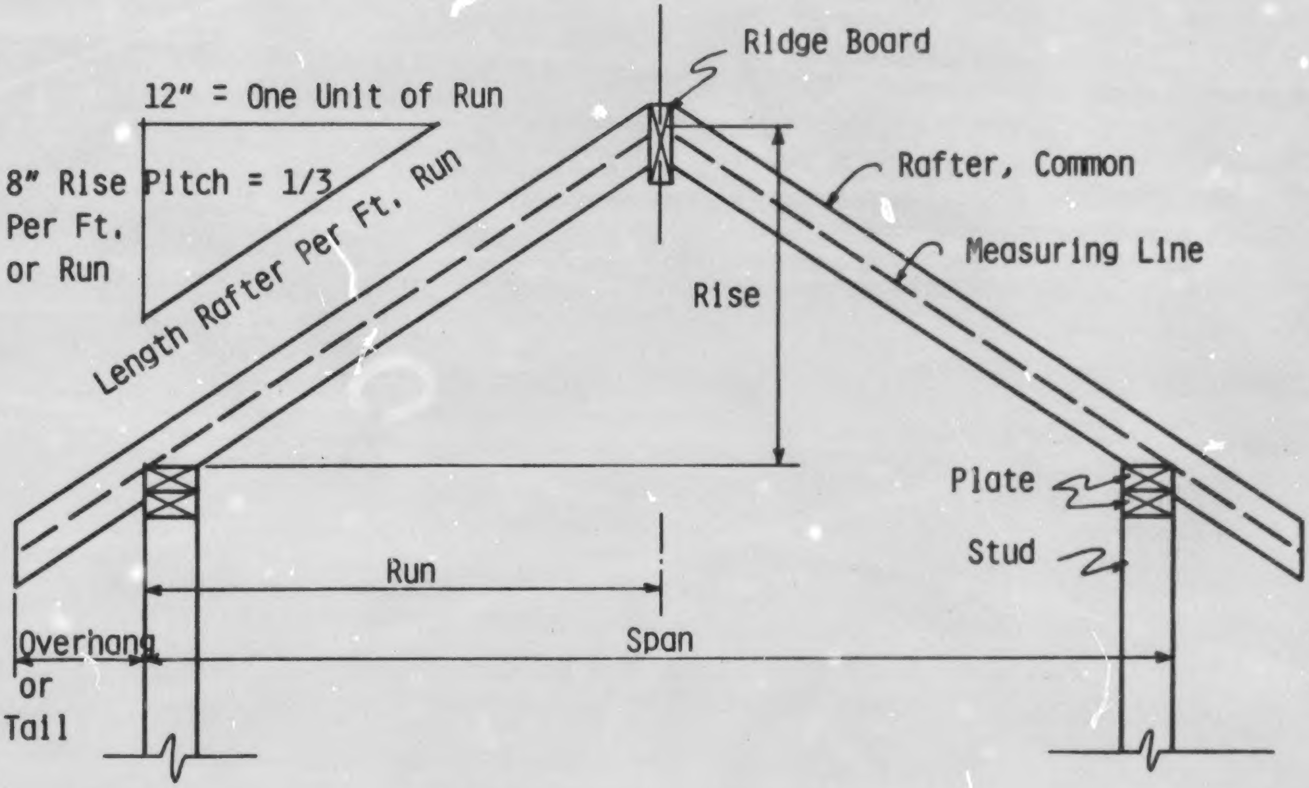
C. Suggested Student Activities

1. Develop problems to calculate roof pitch that will be given to each student.

2. Tape poster board together to an eight foot length. Allow each student to draw a 2" x 4" and cut it out of the poster board. The students will practice laying out a common rafter on this until they are ready to cut out a rafter on actual 2" x 4" lumber.

3. Provide each student with a 2" x 4" 185
   that is 8 feet long. Allow the class to
   layout and cut a rafter per the
   instructor's directions. This will be for
   a grade.

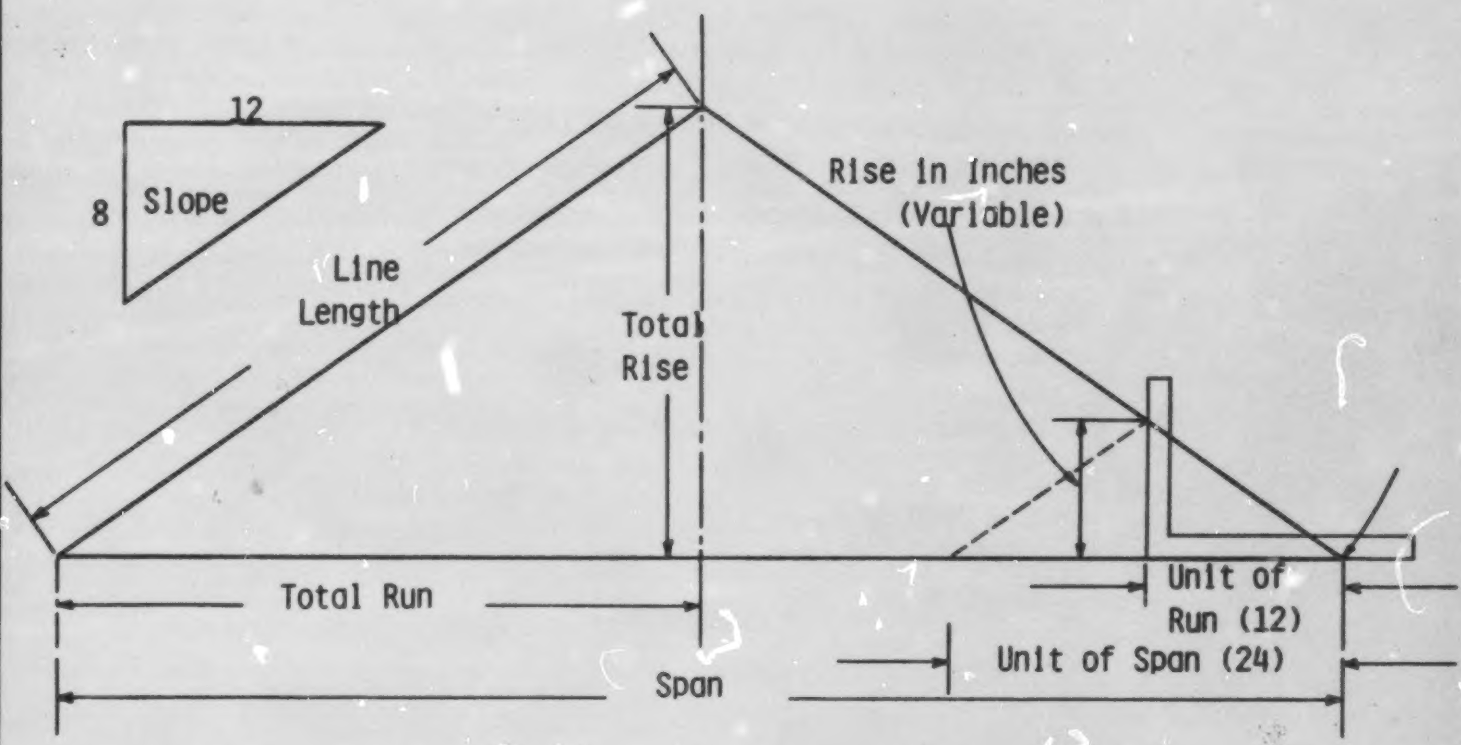
ROOF NOMENCLATURE


Ridge Board
12" = One Unit of Run
8" Rise Per Ft. or Run
Pitch = 1/3
Length Rafter Per Ft. Run
Rafter, Common
Measuring Line
Rise
Plate
Stud
Run
Span
Overhang or Tail

Transparency V-3-A

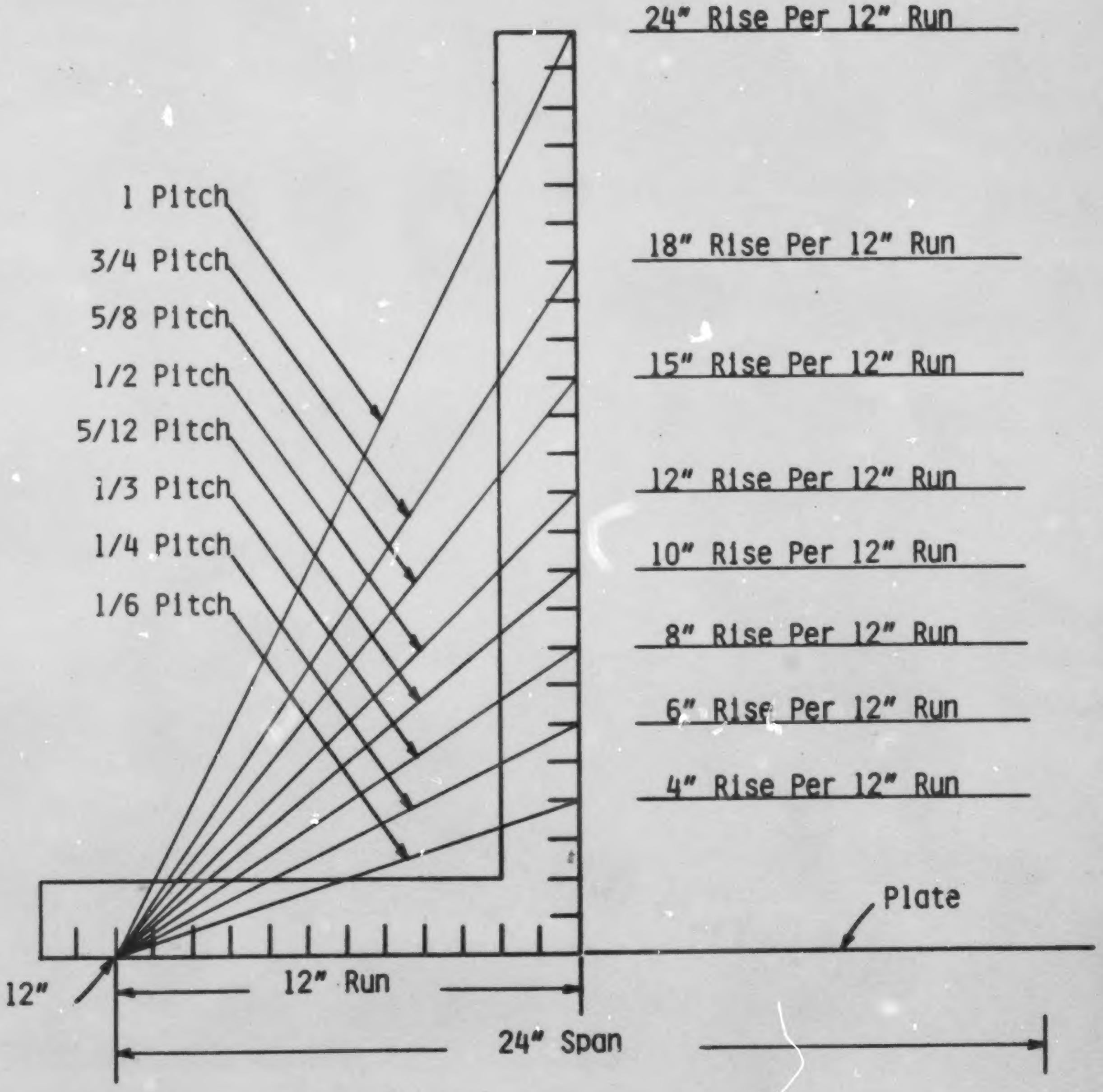
400

ROOF PITCH


12
8
Slope
Line
Length
Total
Rise
Rise in inches
(Variable)
Total Run
Span
Unit of
Run (12)
Unit of Span (24)

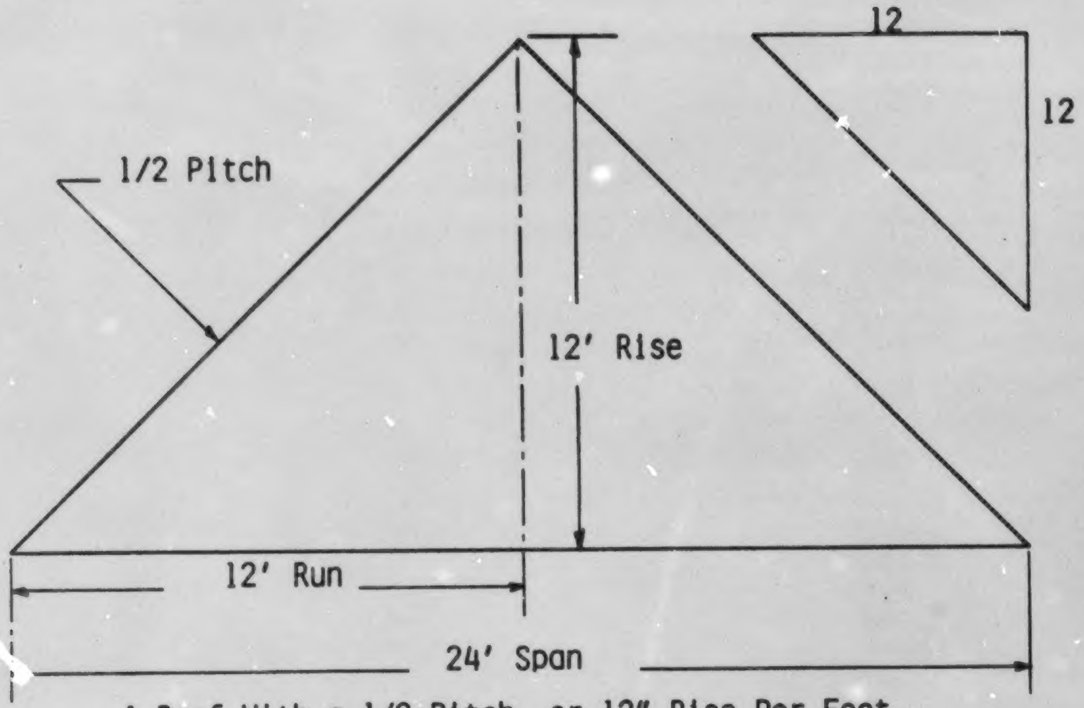
Transparency V-3-B

METHODS OF EXPRESSING PITCH

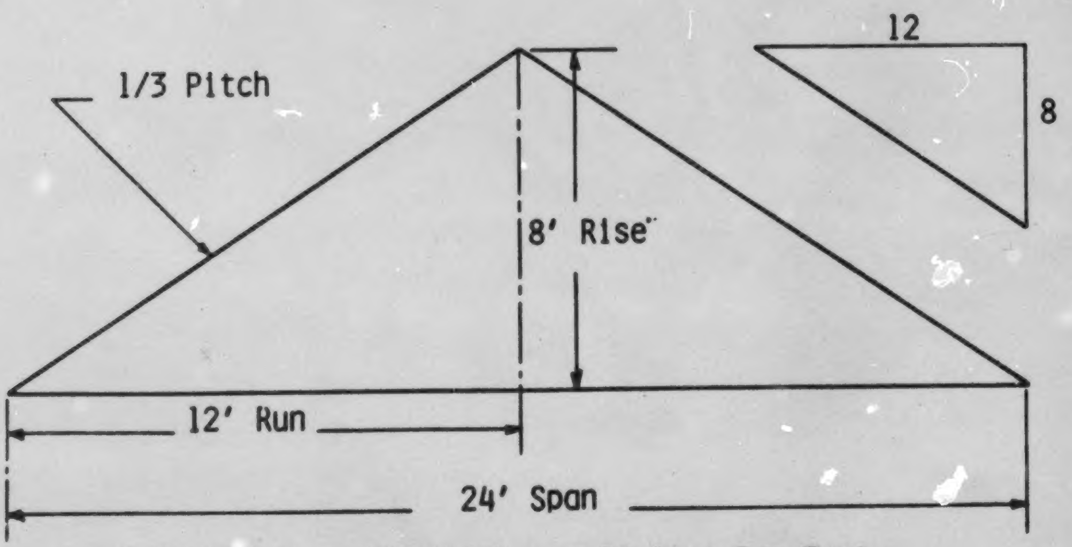

24" Rise Per 12" Run
1 Pitch
3/4 Pitch
5/8 Pitch
1/2 Pitch
5/12 Pitch
1/3 Pitch
1/4 Pitch
1/6 Pitch
18" Rise Per 12" Run
15" Rise Per 12" Run
12" Rise Per 12" Run
10" Rise Per 12" Run
8" Rise Per 12" Run
6" Rise Per 12" Run
4" Rise Per 12" Run
Plate
12"
12" Run
24" Span

Transparency V-3-C

ROOF PITCH


12
12
1/2 Pitch
12' Rise
12' Run
24' Span

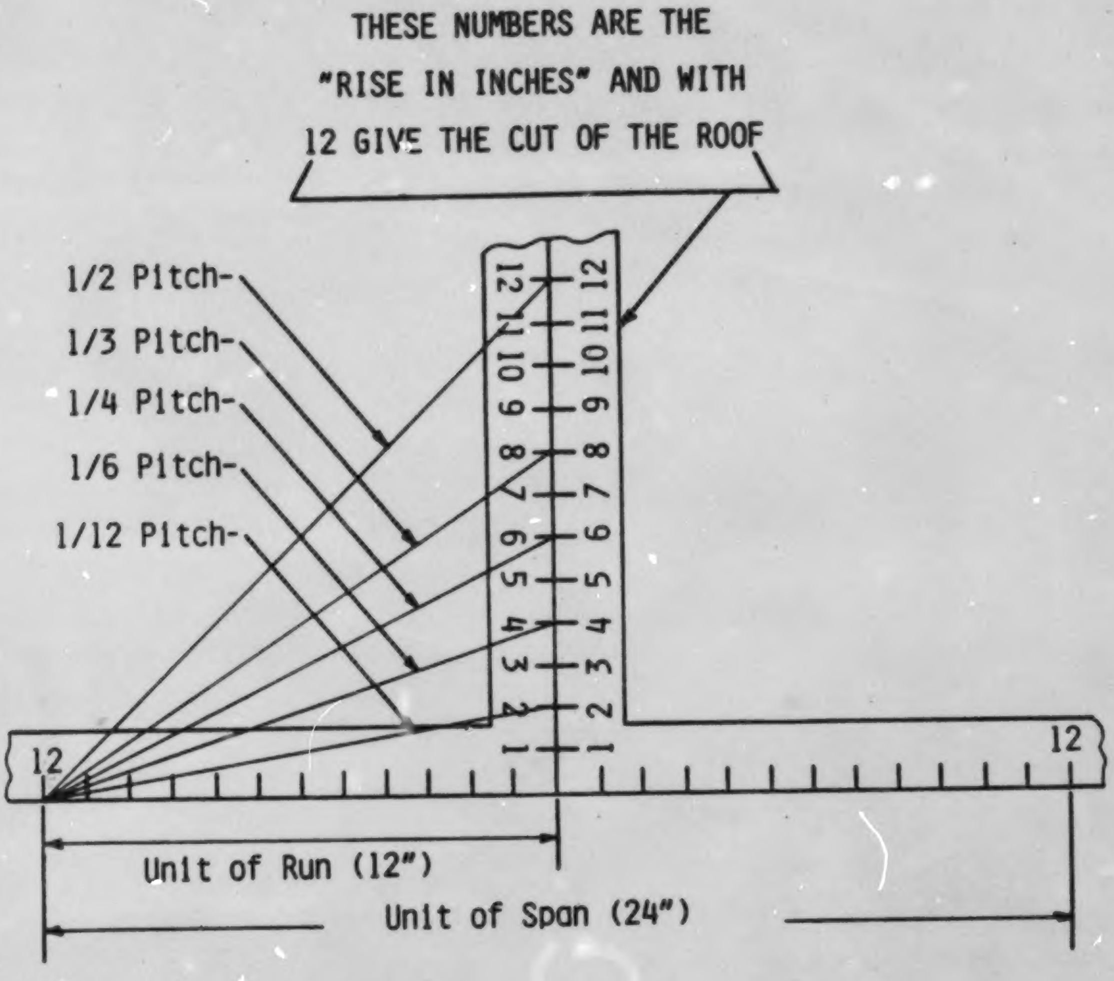
A Roof With a 1/2 Pitch, or 12" Rise Per Foot.


12
8
1/3 Pitch
8' Rise
12' Run
24' Span

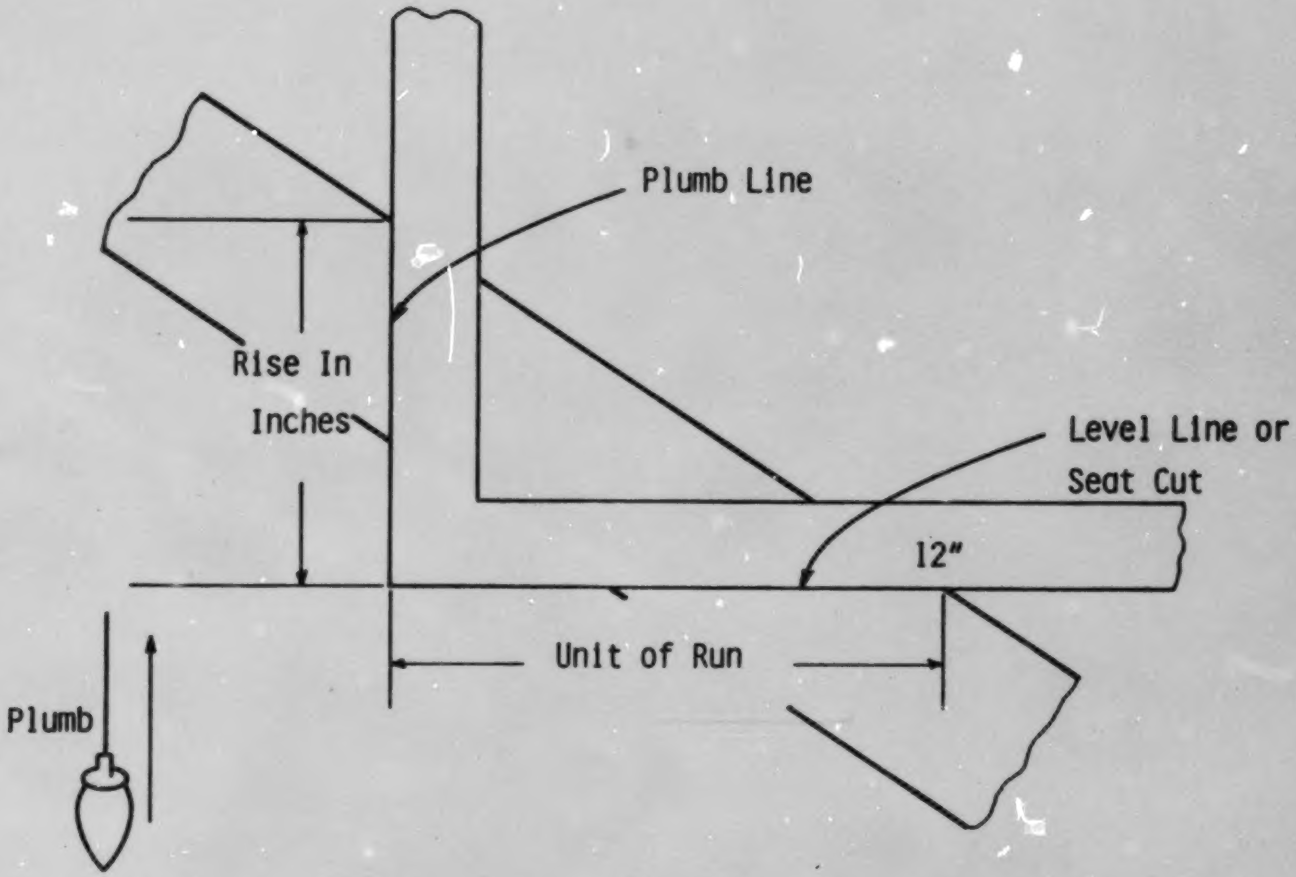
A Roof With a 1/3 Pitch, or 8" Rise Per Foot.

Transparency V-3-D

THE CUT OF A ROOF

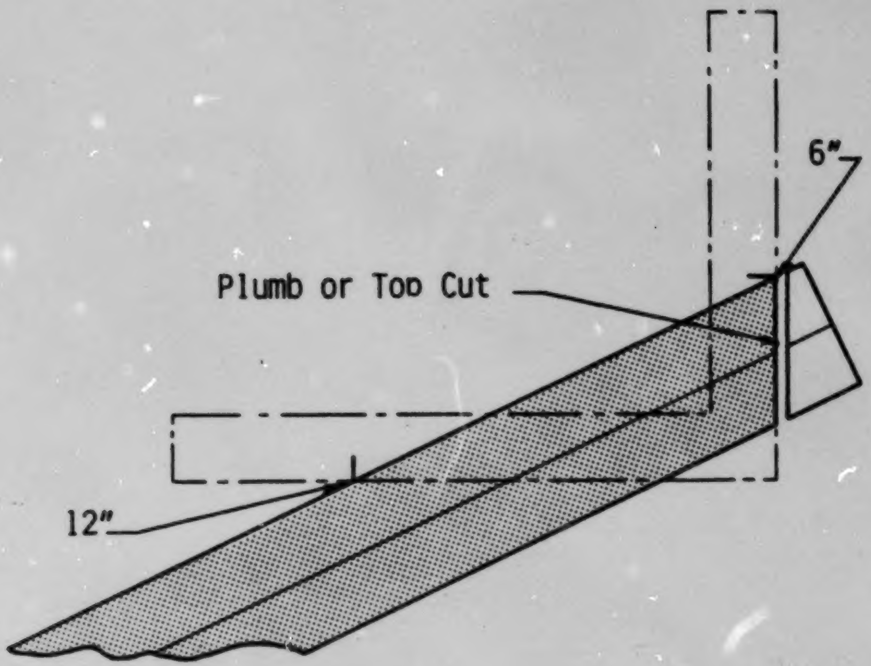

THESE NUMBERS ARE THE
"RISE IN INCHES" AND WITH
12 GIVE THE CUT OF THE ROOF
1/2 Pitch-
1/3 Pitch-
1/4 Pitch-
1/6 Pitch-
1/12 Pitch-
1 2 3 4 5 6 7 8 9 10 11 12
12
12
Unit of Run (12")
Unit of Span (24")

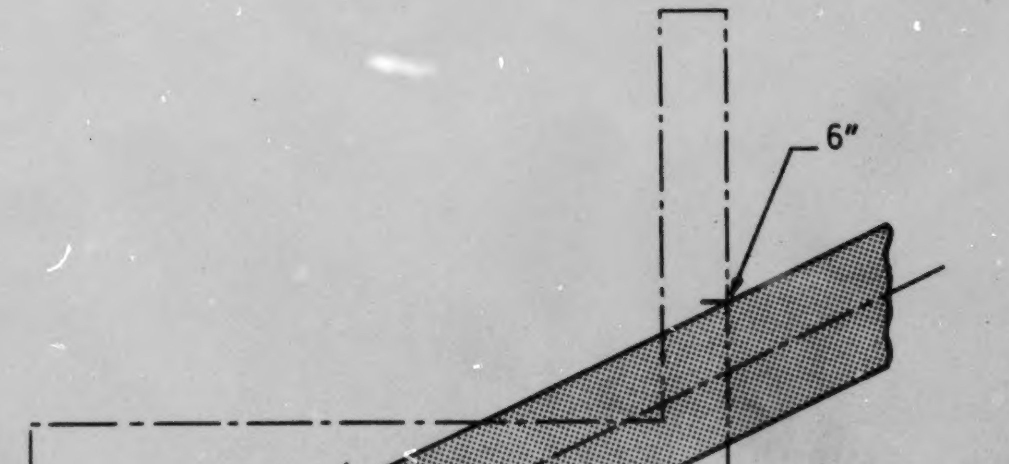
Transparency V-3-E


Plumb Line
Rise In
Inches
Level Line or
Seat Cut
12"
Unit of Run
Plumb

Transparency V-3-F

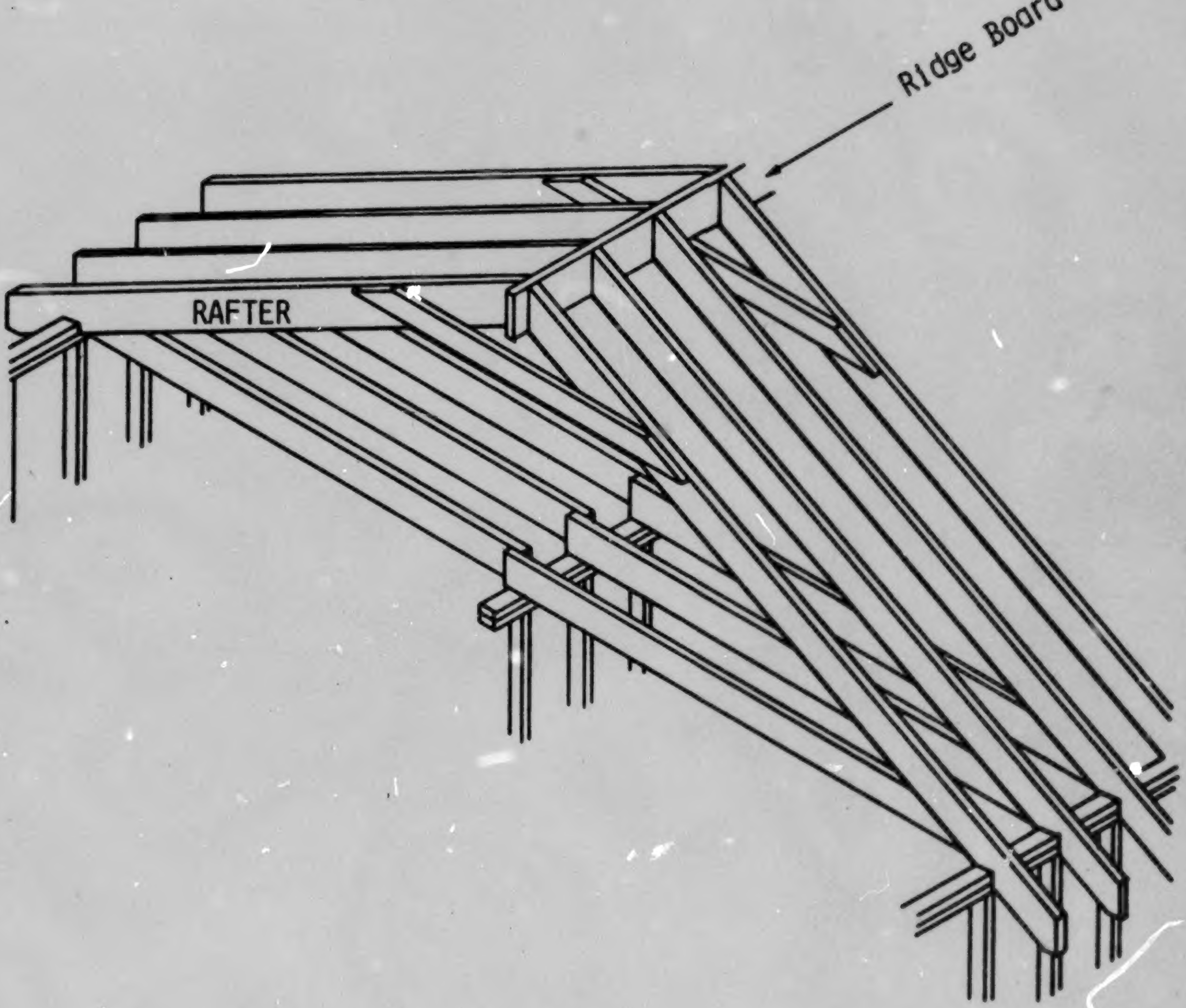
PLUMB AND SEAT CUT


6"
Plumb or Top Cut
12"


6"
12"
Seat or Level Cut

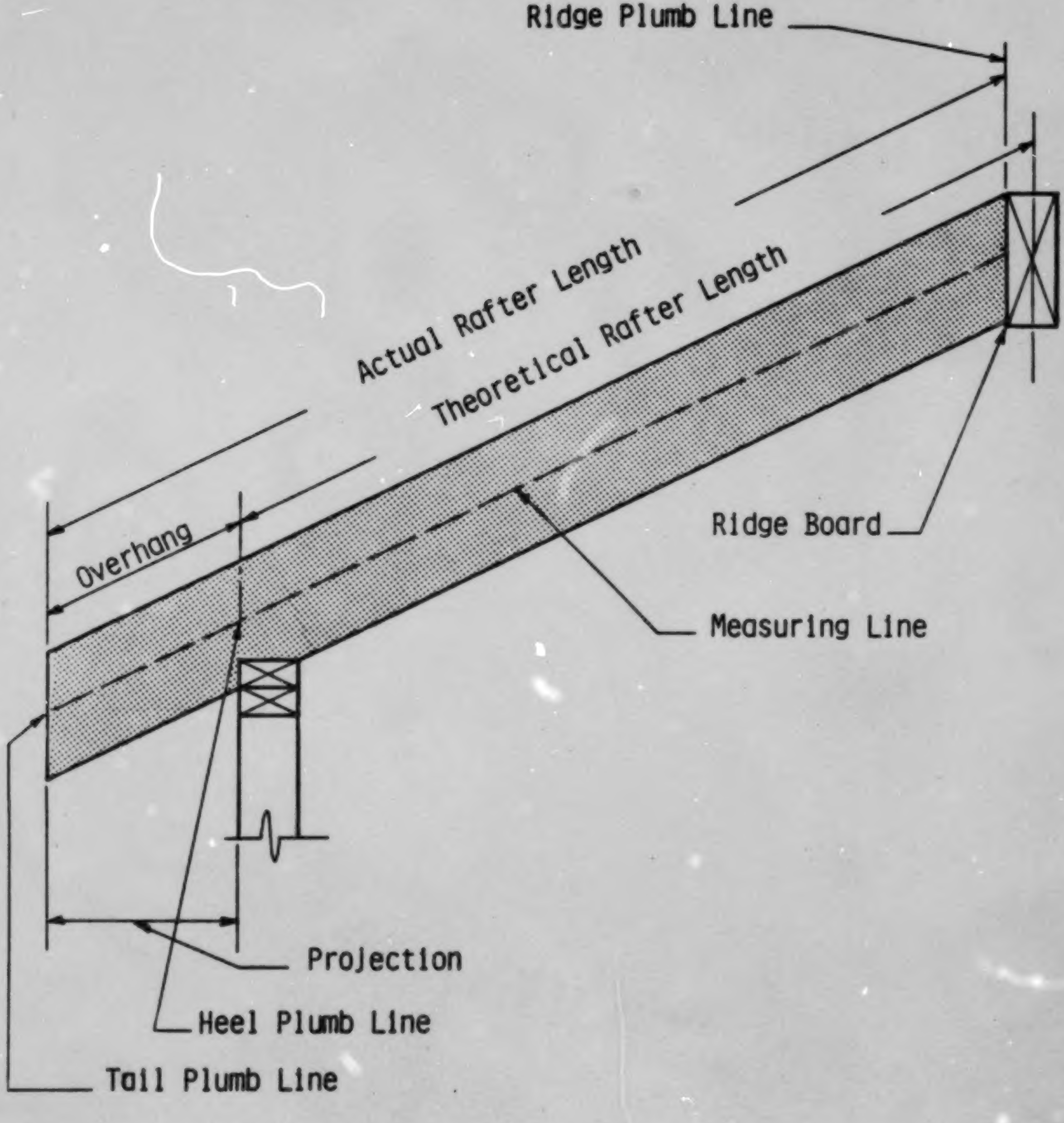
Transparency V-3-G

RAFTER SKELETON


Ridge Board
RAFTER

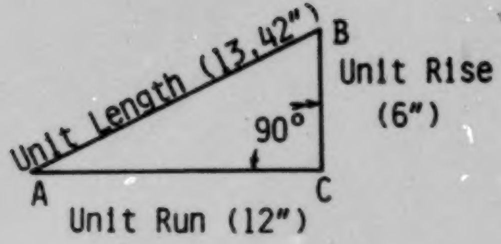
Transparency V-3-H

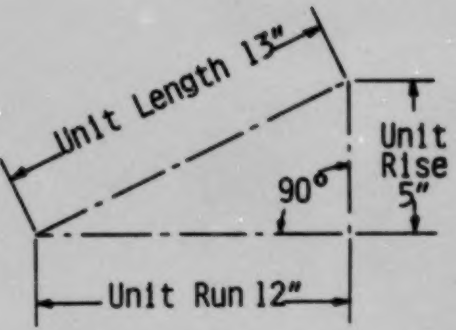
ACTUAL AND THEORETICAL RAFTER LENGTH

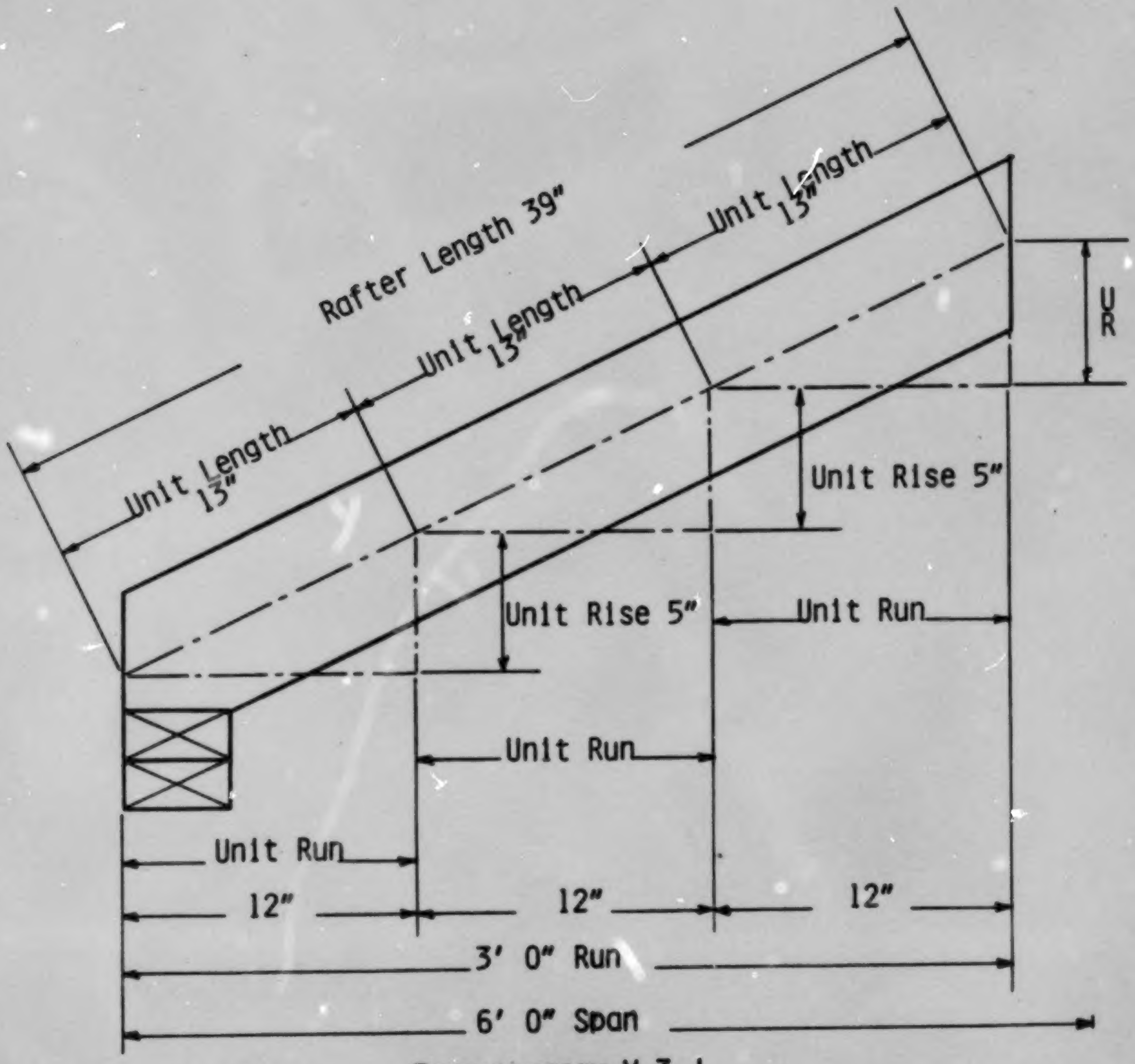

Ridge Plumb Line
Actual Rafter Length
Theoretical Rafter Length
Ridge Board
Overhang
Measuring Line
Projection
Heel Plumb Line
Tail Plumb Line

Transparency V-3-I

UNIT LENGTH METHOD OF RAFTER LAYOUT

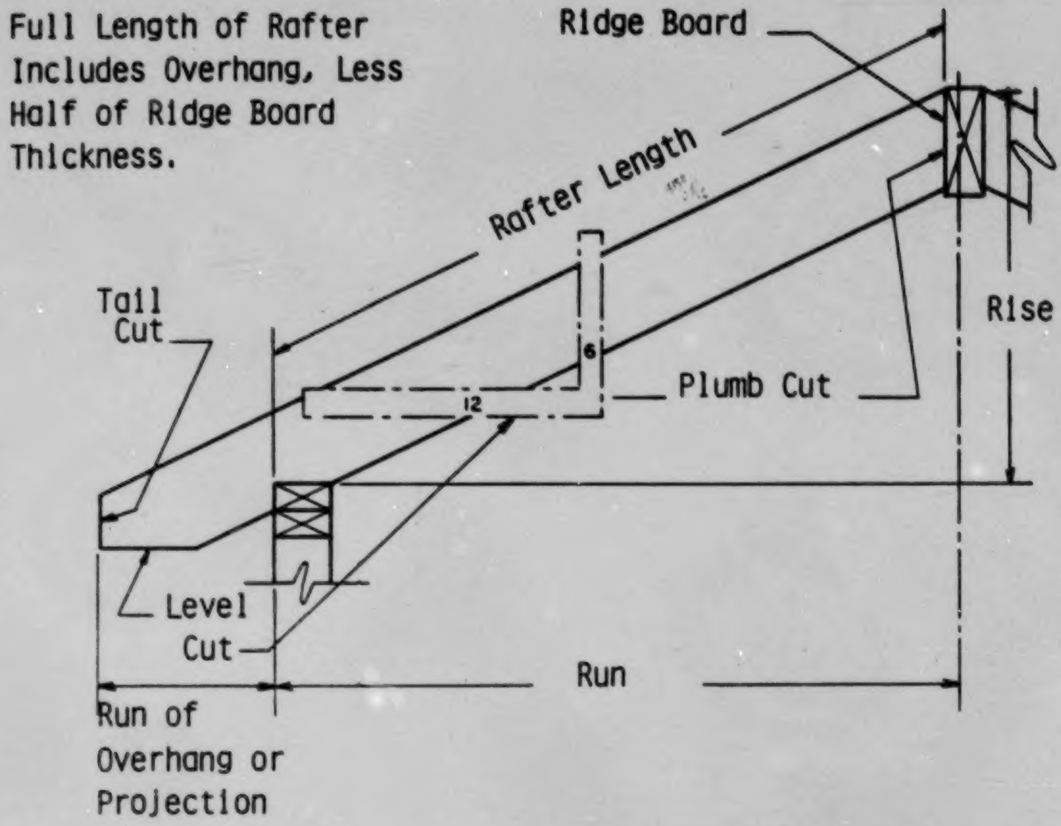

Unit Length (13.42")
B
Unit Rise
(6")
90°
A
C
Unit Run (12")

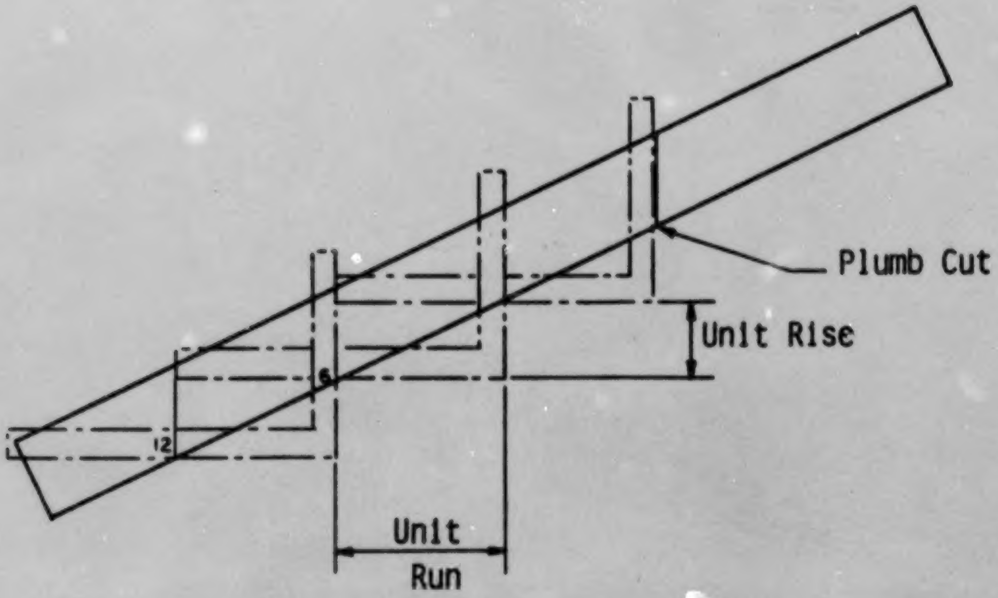

Unit Length 13"
Unit
Rise
5"
90°
Unit Run 12"


Rafter Length 39"
Unit Length
13"
Unit Length
13"
Unit Length
13"
U
R
Unit Rise 5"
Unit Rise 5"
Unit Run
Unit Run
Unit Run
12"
12"
12"
3' 0" Run
6' 0" Span

Transparency V-3-J

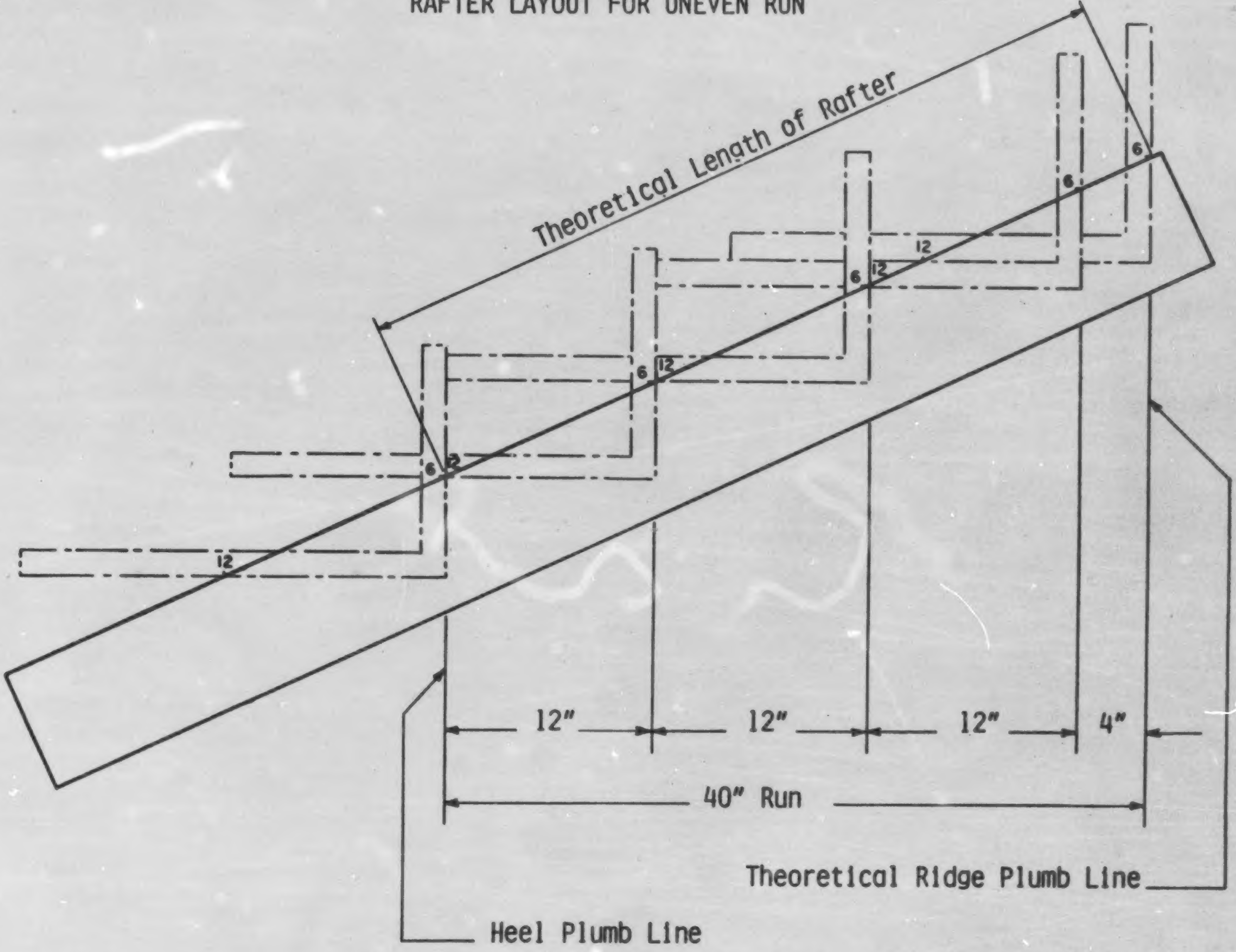
STEP-OFF METHOD OF RAFTER LAYOUT


Full Length of Rafter
Includes Overhang, Less
Half of Ridge Board
Thickness.
Ridge Board
Rafter Length
Tail
Cut
6
12
Plumb Cut
Rise
Level
Cut
Run
Run of
Overhang or
Projection


Plumb Cut
Unit Rise
6
12
Unit
Run

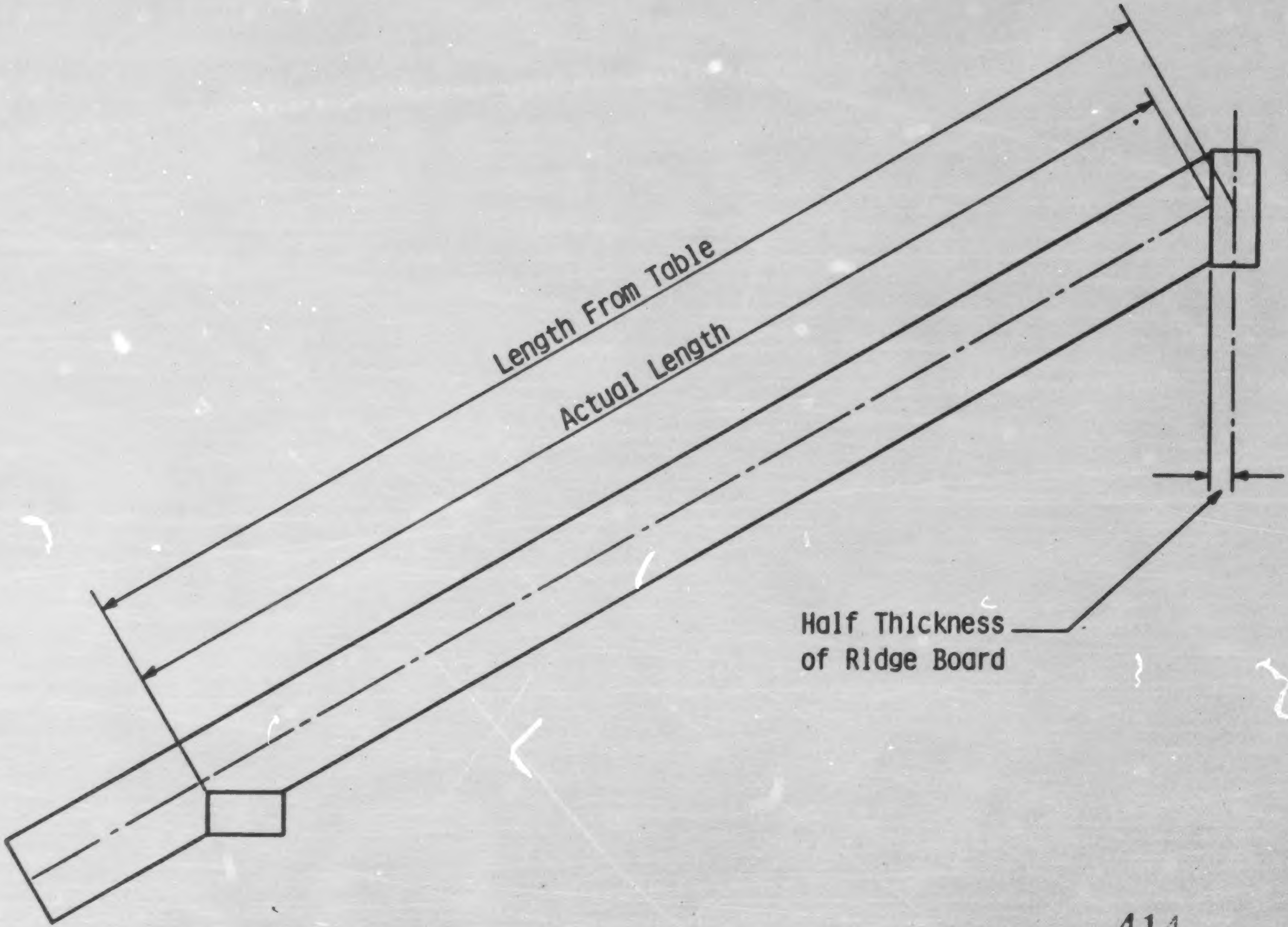
Transparency V-3-K

RAFTER LAYOUT FOR UNEVEN RUN


Theoretical Length of Rafter
6
12
6
12
6
12
6
12
6
12
12"
12"
12"
4"
40" Run
Theoretical Ridge Plumb Line
Heel Plumb Line

Transparency V-3-L

RIDGE BOARD THICKNESS

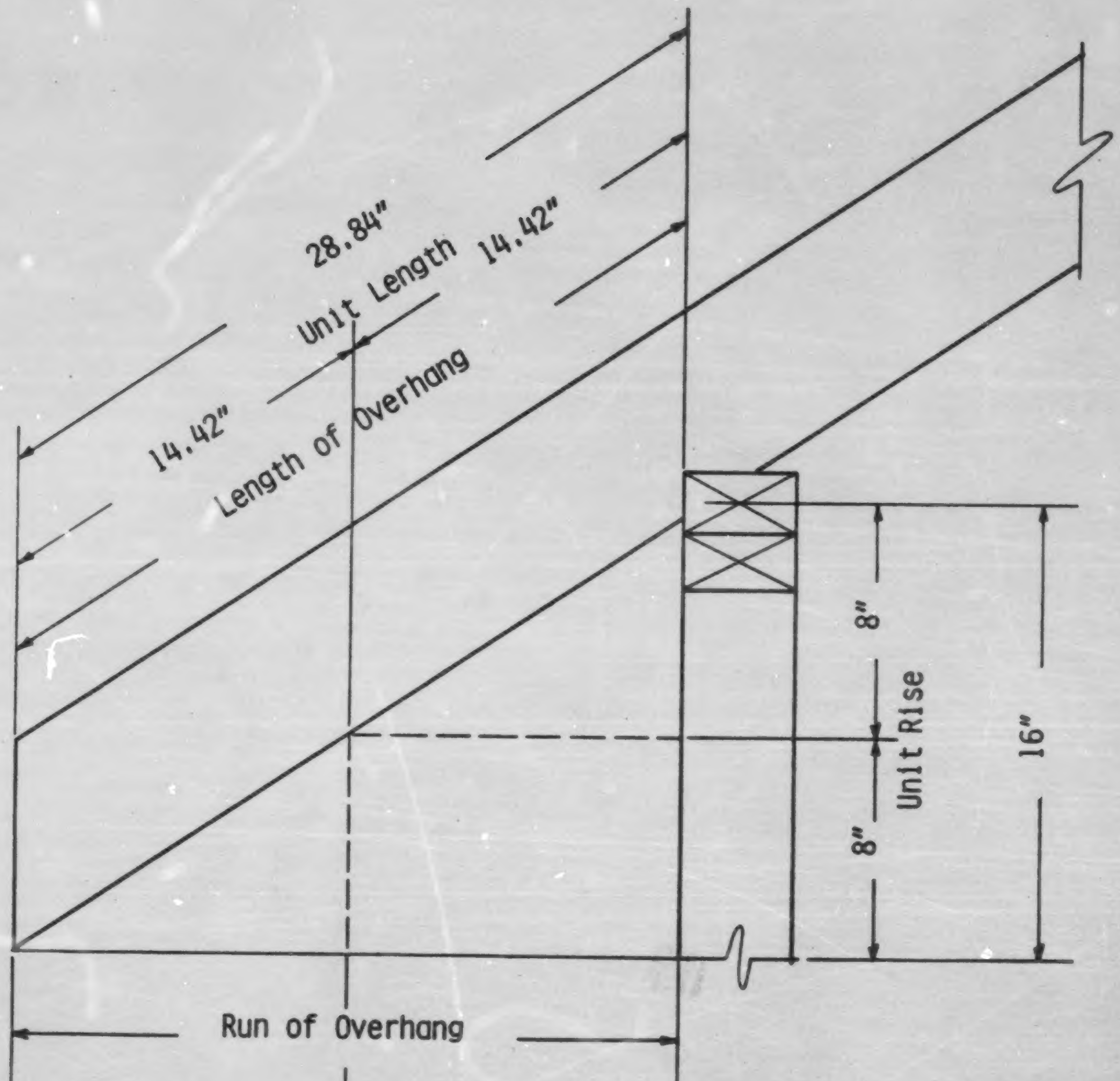

Length From Table
Actual Length
Half Thickness
of Ridge Board

413

414

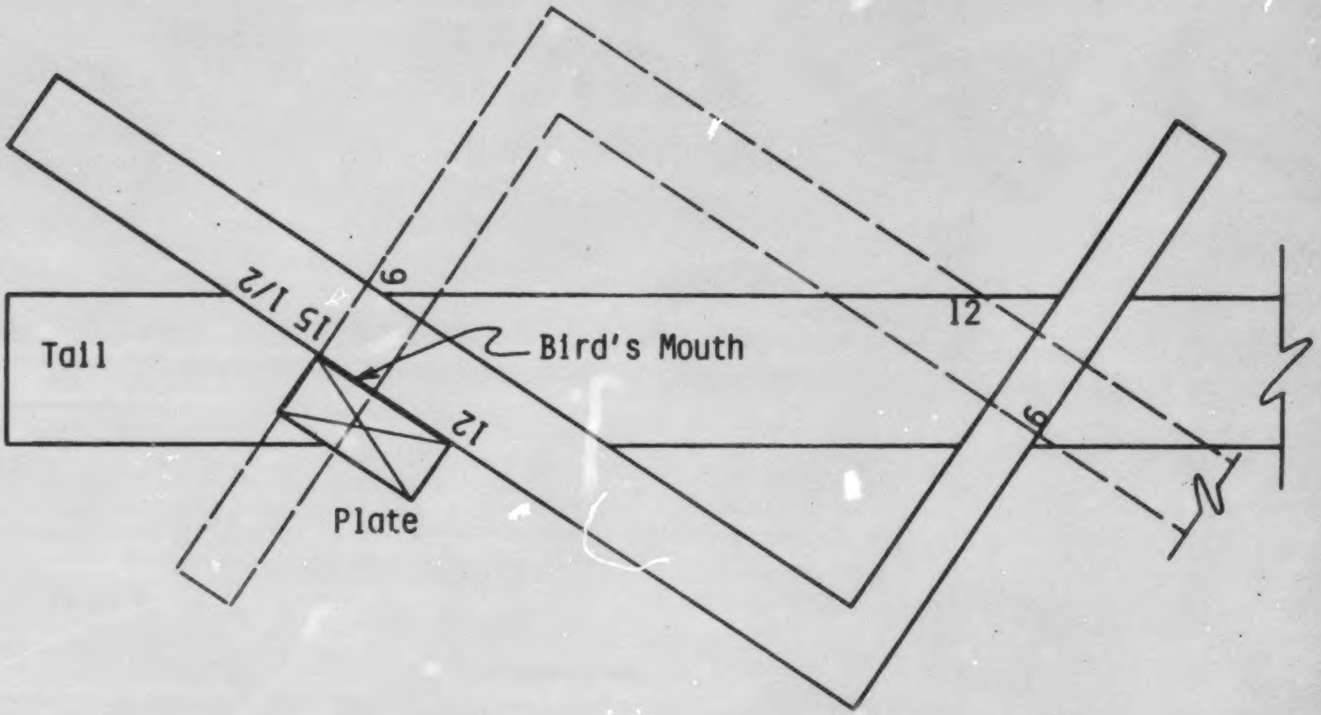
Transparency V-3-M

UNIT LENGTH METHOD OF DETERMINING RAFTER TAIL LENGTH


28.84"
Unit Length
14.42"
14.42"
Length of Overhang
8"
Unit Rise
8"
16"
Run of Overhang
12"
12"
Unit Run
24"

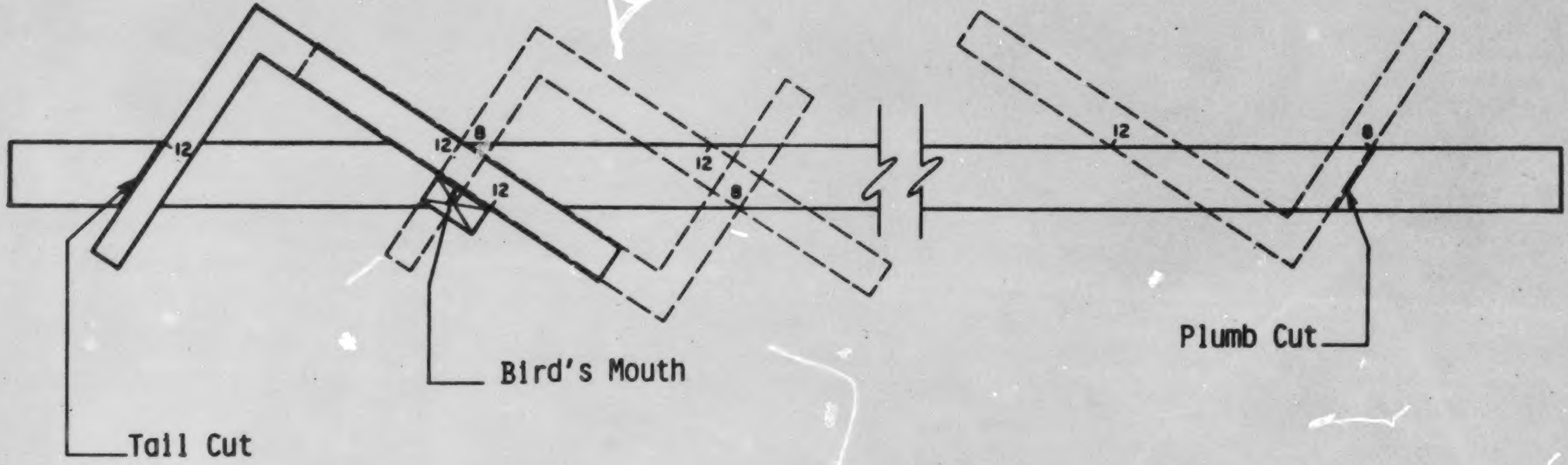
Transparency V-3-N

CUTTING THE BIRD'S MOUTH


15 1/2
9
12
Tail
Bird's Mouth
12
9
Plate

Transparency V-3-0

COMPLETED COMMON RAFTER LAYOUT WITH TAIL


12
12
8
12
12
8
12
8
Tail Cut
Bird's Mouth
Plumb Cut

Instructional Area: Agricultural Mechanics

Instructional Unit VI: Small Engines

Lesson 1: Maintenance, Operation, and Servicing

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Describe the proper procedures to follow in maintaining, operating, and servicing small engines.

2. Specific:

- a. List 10 machines and/or pieces of equipment powered by small engines.
- b. Describe the two major differences in small engines.
- c. List the three basic positions of the crankshaft in small engines.
- d. Define a "stroke."
- e. List and describe the four strokes of a 4-stroke small engine.
- f. List and describe the two strokes of a 2-cycle small engine.
- g. Compare a 4-(stroke) cycle and a 2-(stroke) cycle small engine.
- h. List four major causes that will shorten the life of small engines.
- i. Describe the type of information to be found on a small engine's nameplate.
- j. Discuss why it is important to use the proper tools on a small engine.
- k. Explain why "racing" or "gunning" the engine is detrimental.
- l. Give the maximum ft/min a small engine should operate.
- m. Explain why it is unsafe to operate a small engine in a building.
- n. Describe the first step to follow if the small engine is not running properly.
- o. List the parts on a small engine that should be checked before operation.

p. Explain how to determine if a small engine is a two or four cycle by the compression method.

q. Explain why cleaning a small engine is so important.

r. List the steps to follow in cleaning a small engine.

s. List the three types of air cleaners found on small engines.

B. Review Teaching Material

1. Turner, J. Howard. Small Engines Care-Operation-Maintenance and Repair. Athens, Georgia: American Association for Vocational Instructional Materials, 1978.

C. Special Arrangements

1. Have models available of a 4-stroke and a 2-cycle engine.

D. Materials Required

1. Overhead projector and screen.

II. Presentation of Lesson

A. Motivation

1. This lesson on small engines is very important to everyone because small engines are found on the job almost everywhere. It is estimated that there are over 70,000,000 small engines in use in the U.S.

2. In spite of the popularity of small engines, they are often critized. This is frequently due to the lack of understanding of how the small engine works. Most criticisms of small engines are unfounded. The troubles engines give are generally due to lack of proper service, operation, maintenance, or repair.

3. Upon learning how the small engine works and the servicing procedures, an individual will enjoy a sense of pride and satisfaction in owning and operating it.

B. Content Outline

1. Annual production in the United States of one manufacturer of single-cylinder air-cooled engines is approximately 12,000 units. Mass production, coupled with advanced engineering, has helped to provide these useful engines at prices nearly everyone can afford.

   Small engines are easily adapted to many small jobs because they are:

   Compact,
   Lightweight,
   Easy to service and repair,
   Air-cooled, and
   Self-contained.

   Some of the machines, or equipment, powered by small engines are listed below.

   Post-hole diggers
   Irrigation pumps
   Chain saws
   Small tractors
   Conveyors
   Motorcycles
   Snow blowers
   Rotary tillers
   Refrigerators
   Bush cutters
   Mowers
   Lawn mowers
   Outboard motors
   Power bicycles

   Sump pumps
   Go-Karts
   Mini-bikes
   Ice augers
   Sprayers
   Small feed grinders
   Elevators
   Generators
   Snow vehicles
   Concrete vibrators
   Concrete surfacers
   Earth drills
   Tillers
   Golf carts

   Air compressors (Transparency VI-1-A)

2. Distinguishing Features of Small Engines

   To meet the requirements for different types of equipment, small engines are made with many different features and in many different designs.

   Aside from differences in size (horsepower) of small engines, most of the variations are in the accessories such as different types of starters, carburetors, and ignition systems. Cylinder blocks are made from aluminum or magnesium alloys or from cast iron.

A major difference in the two most common types of small engines is in the number of strokes per cycle. This difference is explained under the heading of "How Small Gasoline Engines Work."

Most of the features may not be quickly recognized, even for someone who has experience with small engines.

There is one distinguishing feature, however, that is easily seen on most engines: the operating position of the crankshaft. There are three basic operating positions:

1. Vertical,

2. Horizontal, and

3. Multi-position.

All crankshafts operate at a right angle to the cylinder. The selection of a vertical, a horizontal or a multi-position crankshaft engine, however, is determined by its adaptability to the equipment on which it is used.

A vertical crankshaft engine has its cylinder in a horizontal position. The vertical crankshaft is well adapted to mounting a mower blade directly to the shaft. If a horizontal crankshaft engine had been used, some type of right-angle drive would have been necessary to align the crankshaft with the mower blade.

A horizontal crankshaft engine may have its cylinder in a vertical, a horizontal, or an intermediate position. The horizontal crankshaft engine is well adapted to supply power to a horizontal transmission shaft. Such engines are often used on small tractors.

A multi-position crankshaft engine will operate in any position. Of course the piston is always at a right angle to the position of the crankshaft. This type of engine is used on chain saws and in other applications where the position of operation may be at extreme angles, or even inverted (upside down). How this is possible is explained under the heading of "Comparing 4-(Stroke)-Cycle and 2-(Stroke)-Cycle Engines."

The crankshaft position may be the first clue as to the design features of an engine.

3. How Small Gasoline Engines Work

The small air-cooled gasoline engine is an internal-combustion engine. All gasoline engines are known as internal-combustion engines because energy for driving the crankshaft is generated within the engine itself. This is accomplished by a fuel-and-air mixture igniting within a confined chamber (cylinder), expanding because of heat, and forcing a piston to move. The piston is connected to a crankshaft which changes the linear (straight-line) motion of the piston to rotary motion.

To make an engine run continuously, however, more has to happen than was previously described. In fact, with the types of internal combustion engines discussed in this lesson, four principal events must take place.

a. Intake, or suction of the fuel-air mixture into the cylinder (Transparency VI-1-B),

b. Compression of the fuel-air mixture,

c. Power: ignition and expansion of the heated fuel-air mixture, and

d. Exhaust of burned gases. (Transparency VI-1-B)

The completion of this series of events is called a "cycle." When the first cycle is completed, the second cycle starts, the third follows, and so on as long as the engine is kept running.

The full travel of the piston in one direction (either toward or away from the crankshaft) is called a "stroke."

Some small engines are designed to complete a cycle during one revolution of the crankshaft (two strokes of the piston). Others require two revolutions of the crankshaft (four strokes of the piston). Thus the names are as follows:

Two-stroke cycle engine, and

Since the 4-stroke cycle engine is easier to understand, it is discussed first.

4. Here is how a 4-stroke cycle engine works.

   a. STROKE 1: Intake--As the piston moves downward, away from the cylinder head:

      The intake valve is located in the cylinder block next to the carburetor. It is kept closed by a strong spring and is opened at the proper time by means of a push rod which is driven by a cam. The cam is located on the camshaft which is geared to the crankshaft, or the cam may be on the crankshaft.

      A carburetor meters the gasoline and regulates the flow of air going into the cylinder through the intake valve. It is in the carburetor that air is mixed with the gasoline vapor.

   b. STROKE 2: Compression--As the piston completes its downward stroke and moves upward:

      The intake valve closes, and the exhaust valve remains closed.

      The fuel-air mixture is compressed to approximately 1/6 of the volume it had at atmospheric pressure. The amount of pressure developed depends on the compression ratio of the engine.

      The compressing action increases the pressure of the fuel-air mixture to approximately 66kPa(75lbs).

   c. STROKE 3: Power--As the piston completes it upward stroke:

      Both the intake and exhaust valves are closed.

      Compressed fuel and air are ignited.

      An electric spark is developed at the spark plug, which ignites the fuel mixture.

The fuel-air mixture burns, and pressure inside the cylinder increases because of the heat of combustion. Combustion temperatures average approximately 1980°C (3600°F).

The pressure of the burning gases inside the cylinder increases to 3 or 4 times that of the compression pressure which is already 6 times normal atmospheric pressure. This pressure was developed during the compression stroke. The combined pressures drive the piston downward, or away from the cylinder head.

The exhaust valve starts to open toward the end of the stroke. The reason the exhaust valve opens toward the end of the power stroke is to allow for better scavenging (more complete removal of burned gases).

d. STROKE 4: Exhaust--When the piston has completed the power stroke and starts upward:

The force of burning gases is gone. The piston movement forces out remaining gases through the exhaust valve.

5. Here is how a 2-stroke-cycle engine works. It is designed to complete all of the actions (a cycle) described for the 4-stroke-cycle engine, but it does them during one revolution of the crankshaft. (Transparency VI-1-C)

a. STROKE 1: Power-exhaust-intake--As the piston moves downward, away from the cylinder head, all three of the following events take place:

Power: Pressure of the burning gases, caused by the heat of combustion, pushes the piston downward. This action provides power to turn the crankshaft through the connecting rod. (The fuel was ignited about the time the piston reached the top of the previous stroke).

Before the piston reaches the end of its downward movement, it exposes in the cylinder two holes, or sets of holes, which are located on opposite sides of the cylinder. These holes are called "ports."

One is the "exhaust port," and the other is the "intake port."

Exhaust: The exhaust port is uncovered first. Hot gases, which are still under pressure from combustion, escape through the open exhaust port.

Intake: After the uncovering of the exhaust port, the intake port is uncovered. A fresh charge of the fuel-air mixture is forced into the combustion chamber. The charge comes from the crankcase where the fuel-air mixture is under pressure.

Pressure develops in the crankcase as a result of the downward movement of the piston. The pressure causes the reed valve to close and pressure to build up in the crankcase. This is only a slight pressure compared with the compression pressure developed in the combustion chamber (approximately 4 to 6 pounds per square inch). It is enough, however, to force the new charge of fuel into the combustion chamber. This also helps to drive out the remaining exhaust gases.

b. STROKE 2: Compression--As the piston moves upward:

Both ports are closed (covered) by the piston so that the fuel-air charge in the cylinder is trapped and compressed.

Just before the piston reaches the top of the upward stroke, a spark from the spark plug ignites the mixture, and it starts to burn. This begins another power stroke.

Another event which does not occur in 4-stroke cycle engines takes place in a 2-cycle engine during the compression stroke. As the piston moves upward, a partial vacuum (low pressure) is created in the crankcase. Atmospheric pressure opens the reed valve and forces a new charge of fuel and air (from the carburetor) into the crankcase.

Most valves in 2-cycle engines are of the metallic reed type.

Reeds are made of metal, phenolic, or plastic. Some 2-cycle engines, however, have sliding valves, and others have rotary valves. 194

6. Comparing 4-(Stroke) Cycle and 2-(Stroke) Cycle Engines

To review briefly, the primary differences in the 4-cycle and the 2-cycle engines are as follows:

The number of power strokes per crankshaft revolution.

The method of getting the fuel-air mixture into the combustion chamber and the burned gases out.

The method of lubricating the internal moving parts.

Since the 2-cycle engine uses the crankcase for storing a reserve charge of fuel-oil and air mixture for the next stroke, the crankcase cannot be used exclusively as an oil compartment for lubricating the engine. Instead, lubrication is supplied by oil that is mixed with the fuel at the time the engine is refueled.

Because of these differences, it is important to know whether an engine is the 4-cycle or the 2-cycle type when servicing, operating, maintaining, or repairing it. When lubricating small engines:

If the mixture of oil and gasoline is put in the oil sump of a 4-cycle engine (instead of crankcase oil) the engine will overheat because of lack of proper lubrication.

If gasoline is put in a 2-cycle engine without first mixing it with oil, the engine will overheat because of lack of lubrication. It will not run long before the piston and bearings will overheat, score, and seize. Two-cycle engines have a sealed crankcase but no oil sump.

One way to recognize a 4-cycle engine is by the presence of its oil sump and by the fact that it has an oil-filler cap or plug where oil can be added to the crankcase. These and other methods for identifying the type of engine will be discussed later.

Since a 4-cycle engine is dependent on an oil sump, the angle at which it operates is critical. Oil distribution can become limited when the engine is tilted too much.

By contrast, the 2-cycle engine is properly lubricated at any angle by small droplets of oil suspended in the fuel-oil and air mixture in the crankcase. (Transparency VI-1-D)

This does not mean, however, that all 2-cycle engines can be operated at any angle. The type of carburetor is also a limiting factor. (Transparency VI-1-E)

7. Importance of Proper Care and Operation

To make small engines "stand up" under the heavy demands to which they are subjected, manufactures provide them with larger crankshafts, larger main bearings, and larger oil supplies per horsepower than those in automotive engines.

They are also built to meet a government specification which provides that the engine must be designed to operate under full load at top speed for 1,000 hours. Some have been known to run as long as 5,000 hours. A thousand hours, however, is usually considered a long life for small engines operated on an irregular basis. For example, if it takes two hours to mow the lawn, and if it is mowed every week for six months, that is only 48 hours per year. At such rate, the mower engine should last 20 years. Occasionally, one hears of small engines lasting 20 years, but most of them give out much sooner than that.

If operating troubles, high maintenance, and repair costs are encountered, and the engine is short-lived, these problems are probably caused by the service and operation the engine receives. For example, the following can occur to the small engine:

a. Dirt is allowed to enter the engine. (Transparency VI-1-F)

It is generally agreed among experts in the automotive industry that more than 50 per cent of early engine failures can be attributed to dirt. This percentage is even higher with equipment such as lawn mowers and tillers. They operate with the engine near the ground, where a large amount of dust is usually present.

b. Failure to check the crankcase oil level regularly (4-cycle engines).

   If the oil level is too low, the engine will not be lubricated properly.

c. Overloading of the engine.

d. Running the engine too fast.

   Some people change the governor setting on their engines in an attempt to develop more horsepower than that for which the engine was designed. If the power output is increased in this manner, trouble will occur.

8. One way to save trouble in servicing and operating the engine is to save and use the operator's manual that comes with the engine. It contains important information for the particular engine (information that one must have when doing many of the servicing jobs).

   To get the proper parts for the engine, give the dealer the following information which is found on the nameplate or stamped on the cooling shroud. Completing a form similar to Transparency VI-1-G will give the necessary information.

   Information that is found on the nameplate is as follows: (Transparency VI-1-H)

   a. Make of engine or name of the manufacturer.

   b. Model number or name of engine. This number usually gives a clue as to the horsepower. Some model numbers refer to other information such as the type of crankcase and accessories. Some include information about certain modifications.

   c. Serial number--It tells the sequence in which the engine came off the assembly line. Modifications are made as production progresses. By knowing the serial number the manufacturer or dealer can tell which modifications have been made. Then the proper parts can be supplied.

d. Type number--The type number identifies engines which require certain parts and accessories which are different from the parts originally designed for the engine.

e. Specification number--This refers to different designs, requested by the equipment manufacturers, such as the length of power take-off end of the crankshaft.

The type and specifications information is included in the model and serial number on some engines. When recording the numbers, be careful not to confuse the engine number with the equipment number. They are very similar. Look for the engine number on the engine proper. Sometimes it is necessary on an old engine to rub the numbers with chalk to bring out raised or indented numbers.

9. One of the most common mistakes made by inexperienced persons is failure to use the proper tools. Never use pliers to loosen or tighten nuts or bolts. Use the proper sized wrench. The use of pliers will round the corners and make the nuts and bolts more difficult to remove. Using wrenches that are too big for the job or using extension handles may result in stripping threads. Keep tools clean, orderly, and in good condition, and they will be enjoyable to use.

These points are so important to the welfare of a small engine that manufacturers will not guarantee engine(s) if there is evidence that an individual is guilty of one or more of the violations listed.

There seems to be a certain amount of pleasure derived from racing an engine, for no apparent reason. All manufacturers warn against it, especially during warm-up. One manufacturer puts it this way:

"Racing an engine or gunning it, to hurry the warm-up period, is very destructive to the polished wearing surfaces of pistons, rings, cylinders, bearings, etc., as the proper oil film on these various surfaces cannot be established until the oil has warmed up and becomes sufficiently fluid. This is especially important on new engines and in cool weather."

Small engines are tough. They will stand much punishment. Abuse during operation, however, shortens their service life. (Transparency VI-1-I)

Information needed when operating the engine is discussed under the following headings:

a. Importance of proper operation. There are many ways by which small engines are abused, but most of them suffer either from overspeeding and/or overloading more than anything else.

   Overspeeding an engine beyond its designed operating speed shortens its life. It can also be dangerous. The engine can actually "blow up" operating at excessive speeds.

   Excessive speeds also affect the life and safety limits of the equipment on which the engine is mounted. According to the American Standards Association, 5,800 m/min (19,000 ft/min) is the maximum safe speed at which the tip of a lawn mower blade should travel. Lawn-mower manufacturers comply with this standard in their design. But if the governor is changed to increase the speed of the engine beyond that which is recommended, the blade may exceed a safe speed.

   For example, for a mower that has a 61 cm (24 in) blade (direct drive), the engine speed should not exceed 3,024 rpm. If it is increased to 3,600 rpm, the blade tip speed will be 6,890 m/min (22,620 ft/min), which is over the safe limit. If it is increased to 4,000 rpm, the blade tip speed would be approximately 7,620 m/min (25,000 ft/min) or approximately 480 km/hr (300mph).

A lawn mower blade is dangerous enough at normal speeds. A test conducted on a rotary lawn mower by one manufacturer revealed some indication of the force generated by small engines. With the engine turning at 3,600 rpm and driving an 45 X 5 cm (18 in X 2 in) blade, the blade was stopped suddenly and the force of impact was measured. Some 38,000 N (34 tons) of impact force were exerted against the stop. (Transparency VI-1-J)

Overloading is also a common abuse of small gasoline engines. Overloading causes overheating and extra loads on the bearings. Overheating contributes to excessive varnish and carbon accumulation inside the engine from breaking down the chemical composition of the oil. This accumulation causes piston rings and valves to stick. Low compression and loss of power result. Generally, it is hard to realize anything is wrong until the valves are burned and/or the rings are broken. Then repairs become expensive.

b. Adjusting the engine speed and load. Manufacturers make a few simple suggestions for operating small engines. At first they may seem unimportant, but they will improve service one gets from the engine if one follows the operating instructions.

1) Read the operating instructions for both the equipment and the engine.

2) Allow the engine to warm up after starting and before bringing it up to speed or applying a load.

Operate at high idle speed (approximately 1/3 throttle). Too low an idle speed will cause the spark plug to become fouled with unburned fuel. 200

CAUTION: Never operate an engine in a closed building. There is a danger of being overcome by carbon monoxide gas. (Transparency VI-1-K)

3) Adjust throttle position. Most small engines are designed for continuous operation under load at full throttle. Manufacturers say that it is better to operate the engine at the continuous operating speed for which it is designed than to risk overloading the engine while it is being operated at a lower speed. This is assuming that the governor adjustment has not been changed. The governor is set so that it will hold the engine speed to a continuous operating speed.

   If the engine is new or rebuilt and is a 2-cycle type, adjust the carburetor for a fairly rich mixture for the first 10 hours. This is better for lubrication of the new parts. There is not a break-in period recommended for 2-cycle engines.

   If the engine is new or rebuilt and is a 4-cycle type, adjust the throttle to approximately 1,000 to 1,800 rpm (about 1/3 throttle) and operate it for 1/2 hour without load. Then increase the engine speed to maximum governed speed without load for 1/2 hour. Operate rebuilt engines an additional 3 1/2 to 4 hours before applying a full load.

4) Apply load to the engine. Apply load gradually. Do not overload.

   If the engine is a new one or is rebuilt, operate it at full throttle for at least 10 hours under light load to assure adequate lubrication during the break-in period, unless the manufacturer recommends a different procedure.

5) Follow the proper operational procedures.

CAUTION: Do not leave the engine running while unattended. There is a danger of the equipment getting out of control and causing personal injury or property damage.

Engines with float-type and suction carburetors may not operate satisfactorily on slopes of more than 15°.

A fuel valve in float-type carburetors may be either forced open or closed when the engine is tilted. Then the engine gets either too much fuel or not enough.

Suction carburetors lift fuel through a suction pipe from the fuel tank or from a sump. If the engine is tilted too much, the carburetor picks up either too much fuel or not enough.

If a 4-cycle engine is tilted excessively, there is a danger of starving it of oil. The oil in the oil sump may not be reached by the dipper or slinger.

If the engine has an oil-bath air cleaner and is tilted too much, the oil will spill into the carburetor and foul the plugs.

6) Stop the engine if it does not run properly. To locate and correct the trouble, first be sure to perform the periodic service required for the engine.

c. Stopping the Engine

1) Remove load from the engine. If an engine suddenly stops under a load, it suffers from "shock." Instead of coasting to a standstill, it is actually stalled. This causes shock on the bearings and increased wear. (Transparency VI-1-L)

2) Reduce engine speed to idle. Allow engine to cool for one or two minutes at 1/3 throttle speed and no load. The engine temperature may be three

times higher at operating speeds than at idle speeds. Stopping the engine at a high temperature subjects it to a sudden cooling which creates stress on all the engine parts.

3) Turn off the ignition switch. On battery ignition engines, leaving the ignition switch "on" will cause the battery to discharge.

CAUTION: If the engine is controlled by an ignition lock and key, remove it before leaving the engine. This is a safeguard against children starting the engine, operating the equipment, and getting hurt. If the engine has no ignition key, remove the spark plug wire from the spark plug.

4) Close the fuel-tank shut-off valve if the engine has one. This care takes the pressure off the carburetor diaphragms and/or float and prevents fuel leaks.

5) Store the engine in a dry, protected area. If the engine will not be used within a period of 30 days, drain the tank and carburetor. Then, just prior to using it, fill the tank with clean, fresh, regular-grade gasoline. This prevents gum from forming in the fuel system.

11. Servicing Small Engines

It is well recognized that to get trouble-free service from the engine, a person must take time to service it regularly. When this should be done varies with the different manufacturers' recommendations, the operating conditions, and the type of servicing performed.

Manufacturers are in general agreement as to the minimal time interval for doing most jobs. Before each operation check the crankcase oil level in 4-cycle engines, and fill the fuel tank with clean, fresh, regular gasoline. If it is a 2-cycle engine, be sure the proper oil is thoroughly mixed with the gasoline.

Two jobs should be done at least every 25 hours of operation. They are servicing carburetor air cleaners, and changing the crankcase oil (4-cycle engines). If operating an engine in extremely dirty and dusty conditions, do these jobs more often.

As a rule, manufacturers recommend an annual cleaning and general inspection. At this time the fuel strainers and crankcase breather are cleaned and serviced.

The following service jobs are discussed in the order one would do them from the start of an operating season. Of course most of them will need to be done repeatedly throughout the season.

The proper procedures for doing these and other service jobs are given under the following headings:

a. Identifying types of small engines--It is difficult to recognize a 4-cycle from a 2-cycle engine unless one understands the principal differences. There are four methods that can used.

   One method is to check for an oil sump and oil filler plug or cap. If it has a sump and filler plug or cap, it is a 4-cycle engine. There is no oil sump on 2-cycle engines.

   Another method is to check for location of the exhaust ports or muffler. On a 4-cycle engine the exhaust muffler connects at the cylinder-head end of the engine cylinder. The 2-cycle engine has an exhaust port about midpoint on the cylinder.

   A third method is to check the information on the name plate or check the operator's instructions. One, or both of them, should mention the oil specifications, or fuel-and-oil specifications. If either one gives the crankcase capacity or a kind of crankcase oil, this applies only to 4-cycle engines. If mixing oil and gasoline is mentioned, this would identify it as a 2-cycle engine.

If none of these methods is adequate and one is still uncertain about the identification of the engine, use the compression method. Proceed as follows: 204

1) Disconnect the spark plug to prevent the engine from starting.

   Make sure the connector is not touching the spark-plug terminal.

2) Put a chalk mark on the starter flange or pulley.

3) Crank the engine slowly by hand.

   If resistance (caused by compression) is felt at only every other revolution, it is a 4-cycle engine.

   If the resistance (caused by compression) is felt at each revolution, it is a 2-cycle engine.

b. Cleaning small engines--If one fails to clean the engine regularly, its efficiency is reduced along with its time of useful service. For example, the following may happen:

1) The engine overheats.

2) Dirt gets inside the engine.

3) Rubber parts soften and break down.

4) Loose nuts and cracks are covered and go unnoticed until major damage is done.

5) Neglect becomes a habit.

Overheating can be caused by dirt and grime on the outside of the engine and by a clogged or restricted exhaust system.

When dirt and grime collect on the fins, they tend to insulate the fin area so that heat does not move readily into the air stream. The engine temperature increases excessively during operation. The collection of deposits can reach the point at which the space between the fins may be completely blocked and the engine overheats.

A clogged muffler will also cause an engine to overheat. It creates a back pressure in the cylinder and prevents the hot gases from escaping readily. One-third of the combustion heat is given off through the exhaust system.

Overheating, in turn, causes valve-guide distortions, cylinder warping, scuffing and scoring of cylinder walls, sticking valves, loss of power, and eventually engine failure.

Another reason for keeping your engine clean is to prevent dirt form getting inside the engine. Much of the dirt that enters the engine comes from deposits on the outside. Dirt particles which enter the lubrication area of an engine cause rapid wear on bearings and other surfaces that slide against one another. Once dirt mixes with oil, a harmful grinding mixture is developed.

Unless one is extremely careful, dirt will enter the engine when a person checks the crankcase oil level or refuels the engine.

Dirt may also get into the air cleaner assembly when the filter is removed. This restricts air flow into the carburetor; then some of the dirt will enter the cyclinder during engine operation.

With 2-cycle engines dirt and other foreign materials may enter the exhaust ports and lodge on the cylinder walls.

Oil or gasoline which collects on rubber parts, such as the spark plug wire, V-belt, and rubber hoses, causes them to soften and deteriorate rapidly.

Another advantage of cleaning an engine is to reveal any part that might have become defective, loose, or broken. These parts can be repaired before extensive damage is done.

Most engines are sold with a warranty. 206
The warranty provides for the replacement of defective parts for a period varying from approximately 45 days to as long as one year after the date of purchase. If the engine is new and one can discover defects during that period of time, one will save the cost of putting the engine back into top operating condition.

Once an individual gets behind on servicing the engine and it becomes dirty and rusty, the owner loses a sense of pride in owning the engine and has a tendency to neglect and abuse it. The individual is then more likely to overload the engine, operate it too fast, and neglect to service it properly.

Tools and materials needed to clean a small engine

1) Slot-head screwdrivers (4" and 6")
   Phillips-head screwdrivers (4" and 6")

2) Socket set (including 3/8", 7/16",1/2", 5/8", and 9/16" sockets and 3/8" ratchet handle

3) Open-end wrenches of the same sizes indicated for socket wrenches

4) Nut drivers (1/4", 3/8")

5) Wire brush

6) Pail (approximately 10-qt. capacity)

7) Paint brush

8) Water hose equipped with nozzle

9) Small wooden scraper and/or a small putty knife

10) Old toothbrush, if available

11) Commercial degreaser (Petisol 404, Gunk, or equivalent); or petroleum solvent (mineral spirits, kerosene, or diesel fuel); or steam cleaning equipment (Transparency VI-1-M)

12) Hand sprayer

A fire extingusisher is also desirable in case of fire. It should be of the dry-chemical, carbon-dioxide, or foam type to be effective for gasoline or other petroleum fires.

If an air compressor that can be set for a pressure of approximately 100 pounds (per square inch) is available, it is very helpful in removing dirt from hard-to-reach places.

The following is the recommended procedures for cleaning your engine:

1) Allow the engine to cool if it has been running;

2) Remove the blower shroud and cylinder baffles;

3) Inspect for oil leaks and fuel leaks;

4) Remove air-cleaner and cover air-cleaner opening;

5) Clean the exhaust system;

6) Apply solvent on areas that need cleaning;

   CAUTION: Do not use gasoline for cleaning the engine. It is highly flammable and an extreme fire hazard.

   CAUTION: If a degreaser is used, check the instructions on the can. Some are flammable and dangerous if used in a closed building or near a flame.

7) Let the solvent set approximately 5 minutes whether a degreaser, petroleum solvent, or a mixture of the two is utilized;

8) Remove solvent from the engine surface;

9) Check for areas that have been missed;

10) Remove protective covers; 208

11) Replace the carburetor air cleaner; and

12) Operate the engine immediately for three to five minutes.

c. Servicing carburetor air cleaners. The carburetor air cleaner is one of the most important parts of your engine. This was proved by one manufacturer who conducted an experiment to learn the effects of operating an engine under dirty conditions without an air cleaner. The engine failed after only three and one-half hours of operation. The cylinders, pistons, rings, and bearings were badly worn.

For the air cleaner to protect your engine from dirt, it must be serviced properly. Servicing consists principally of cleaning the filter element.

Types of air cleaners and how they work--There are three types of air cleaners used on small gasoline engines -- (1) oil-bath, (2) oiled-filter, and (3) dry-filter type. All three of them do a satisfactory job of removing harmful dirt from the air going into the engine, when serviced properly. (Transparency VI-1-N and O)

It is important that a person know how to identify types of air cleaners and how they work in order to use the proper procedures for servicing them.

The oil-bath cleaner washes dirt particles from the air by forcing it through a bath of oil.

Air enters the cleaner under the edge of the cover. It is directed downward to the bottom of the oil cup. When the air reaches this point, its path of travel changes abruptly to an upward movement.

Oil in the filter is picked up and carried along with the air. This action coats the dirt particles with oil and causes them to lodge in the mesh of the filtering element (a metallic maze). As more dirt and oil collect in the filtering element, oil drains back into the outer chamber of the oil cup. Here the dirt settles out, and the oil is used again to trap more dirt.

The oiled-filter of the air cleaner consists of a filtering material such as aluminum-foil mesh, or maze, or a sponge-like plastic material called polyurethane. Either material is coated with oil before being installed.

The filter is designed so the air passes over a large area of oiled surface. Oil on the filter material picks up dust and dirt particles and prevents them from going into the engine.

Many people think that oiling this type of filter is not necessary, but without oil the filter is of no practical value. Dirt goes right through it.

The dry-filter type of air cleaner consists of a porous filtering element. It is usually made of paper, but some are made of moss or hair.

The dry-filter type air cleaner has a filter with minute (very small) openings that keep all except extremely small particles from passing through. This type of filter is not dependent upon oil for catching the dust and dirt.

Dry-filter cleaners have the following advantages:

They are easier to service;

Fuzz and chaff cause less restriction to air passage;

They are more efficient at a wide range of engine speeds; and

When the air cleaner needs servicing, the engine warns a person by failing to run properly. Dirt builds up on the filter, and the engine starves for air. This results in a choking effect.

Dry-filter air cleaners cost more to maintain than other cleaners because the filter element requires replacing quite often. How often depends upon the operating conditions.

A 3 hp engine operating at 3,600 rpms requires approximately 6.5 cu ft of air.

Most manufacturers recommend servicing the air cleaner every 25 hours, if the engine is being operated under ideal conditions.

d. Servicing fuel strainers--Fuel strainers are located between the carburetor and fuel tank or can be found inside the fuel tank.

The purpose of a fuel strainer is to prevent trash and dirt from entering the engine.

If a small engine is not getting enough fuel to the carburetor to run properly on, the fuel strainer should be checked.

It is recommended that the fuel strainer be checked every 25 hours of normal operation.

e. Servicing crankcase breathers--Four-cycle engines have a crankcase breather that provides for the following:

1) Avoids a build-up of excessive pressure in the crankcase,

2) Allows for removal of harmful gases in the crankcase,

3) Maintains a partial vacuum, and

4) Keeps out dust and dirt.

Crankcase breathers should be cleaned at least once a year.

NOTE: Two-cyle engine crankcases are not vented because of fuel and oil entering the combustion chamber through the crankcase.

C. Suggested Student Activities

1. Have the students perform a daily operational check on a small engine as though they were actually going to be using the engine.

2. Assign the students to make a list of malfunctions that they find on small engines around the student's home.

3. Have the students give a safety demonstration with the "do's and don'ts" of operating a small engine.

WHY SMALL ENGINES ARE ADAPTABLE TO MANY KINDS OF JOBS

LIGHTWEIGHT

ECONOMICAL ON FUEL USE

COMPACT

PORTABLE

AIR-COOLED

EASY TO SERVICE

SOURCE OF POWER FOR SMALL EQUIPMENT

EQUIPMENT POWERED BY SMALL ENGINES

MOWERS

CHAIN SAWS

CONVEYORS

ELEVATORS

POST HOLE DIGGERS

SMALL FEED GRINDERS

CONCRETE SURFACERS

AIR COMPRESSORS

BRUSH CUTTERS

ROTARY TILLERS

IRRIGATION PUMPS

SPRAYERS

CONCRETE VIBRATORS

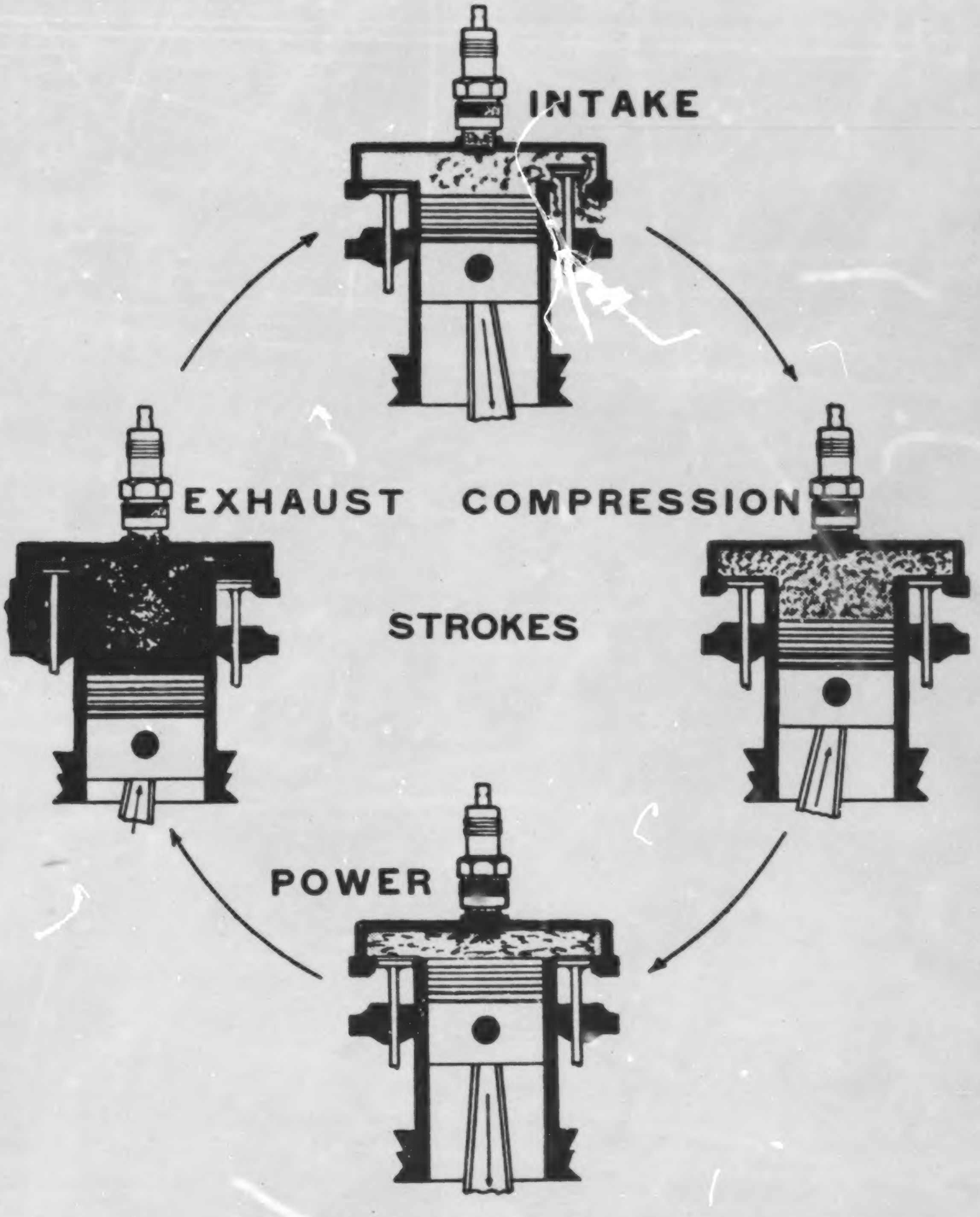
GENERATORS

OUTBOARD BOATS

SMALL TRACTORS

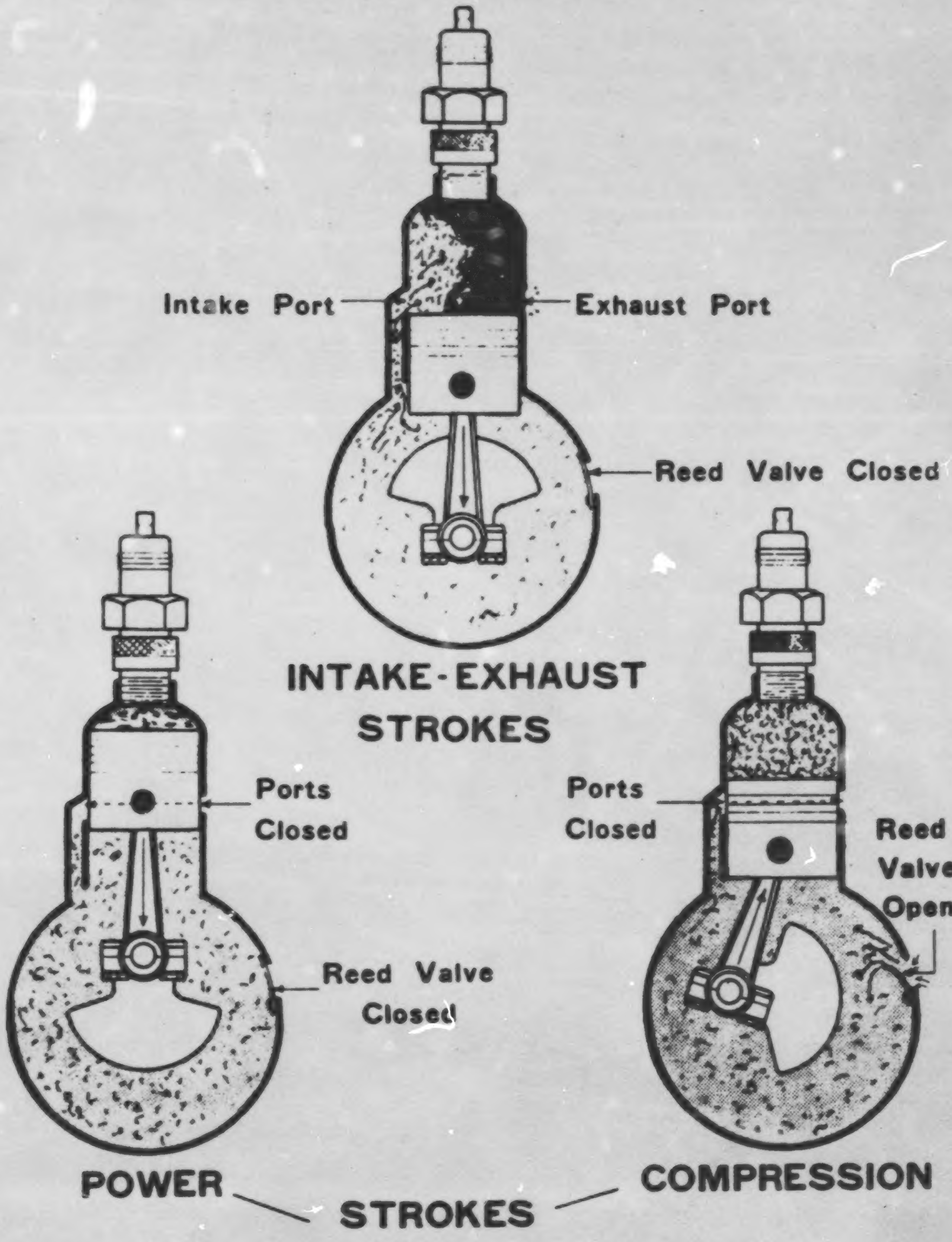
TRANSPARENCY VI-1-A

OPERATION OF A FOUR-CYCLE ENGINE

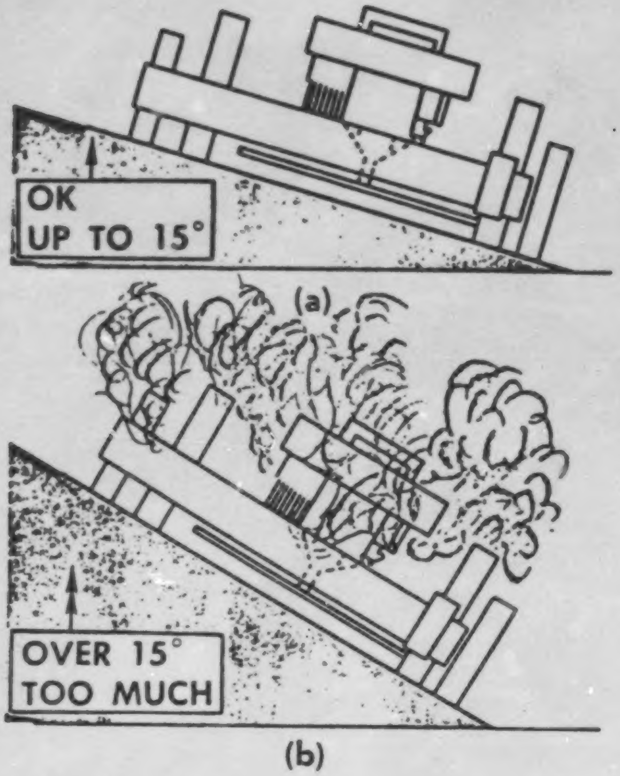

INTAKE
EXHAUST
COMPRESSION
STROKES
POWER

TRANSPARENCY VI-1-B

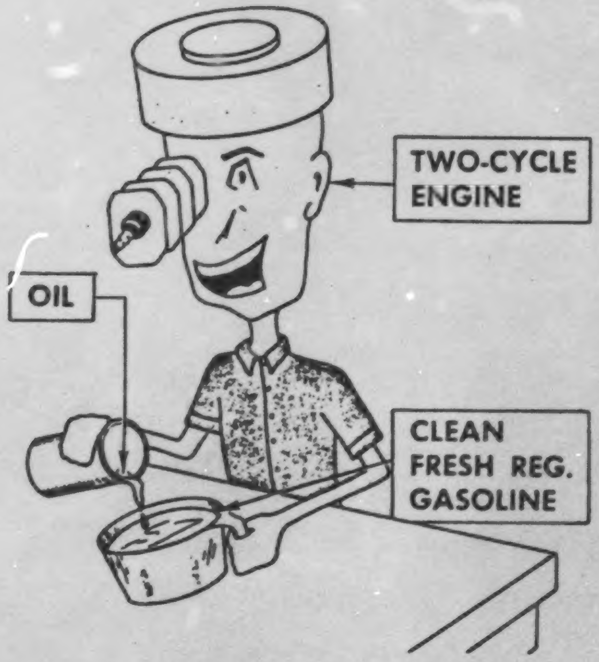
OPERATION OF A TWO-CYCLE ENGINE


Intake Port
Exhaust Port
Reed Valve Closed
INTAKE-EXHAUST STROKES
Ports Closed
Reed Valve Closed
Ports Closed
Reed Valve Open
POWER
STROKES
COMPRESSION

TYPE OF SMALL ENGINE DETERMINES USE

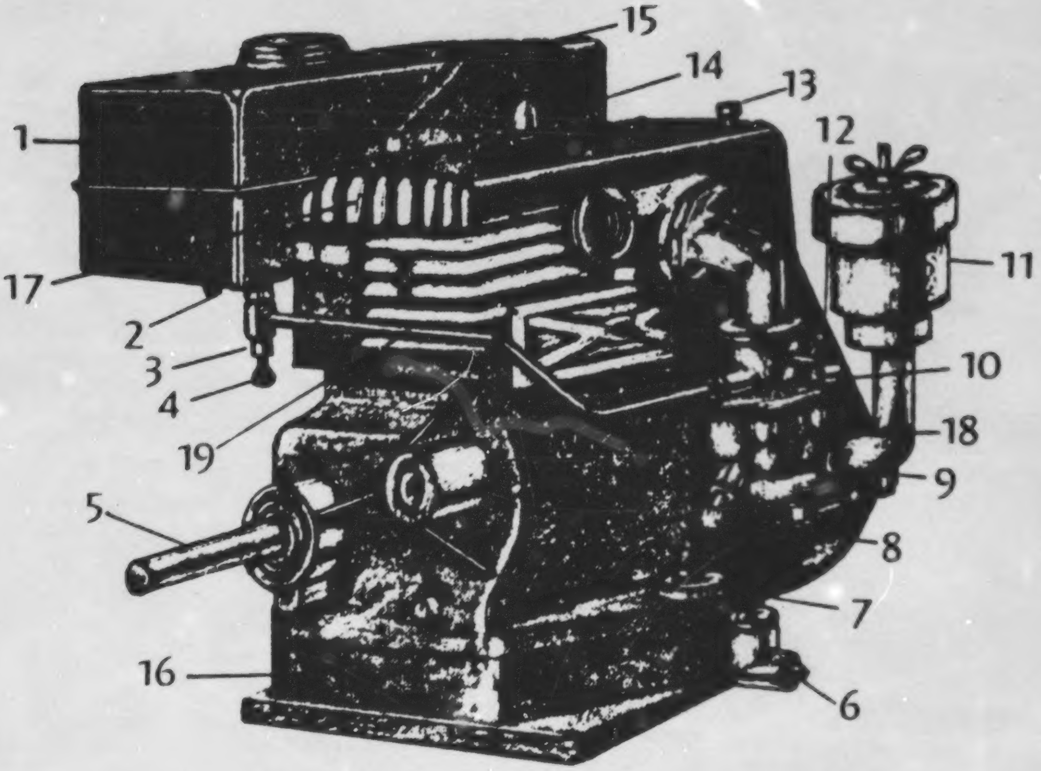

OK
UP TO 15°
(a)
OVER 15°
TOO MUCH
(b)

OPERATING SOME ENGINES AT TOO GREAT AN ANGLE MAY STARVE THE ENGINE OF FUEL OR OIL AND TAKE OIL INTO THE CARBURETOR FROM THE AIR CLEANER


TWO-CYCLE ENGINE
OIL
CLEAN FRESH REG. GASOLINE

TWO-CYCLE ENGINES REQUIRE A MIXTURE OF GASOLINE AND OIL

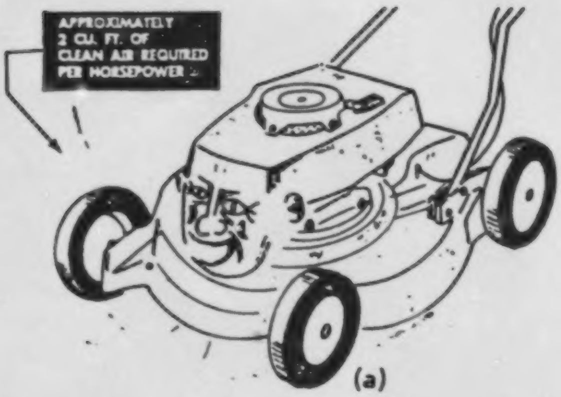
SOME MAJOR PARTS OF A SMALL ENGINE



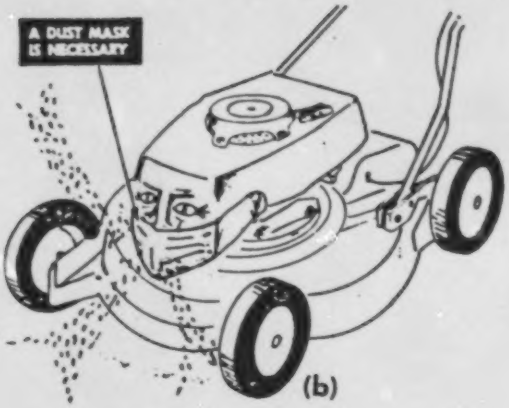
1. FUEL TANK
2. DRAIN PLUG
3. FUEL FILTER
4. FUEL VALVE
5. POWER SHAFT
6. OIL DRAIN PLUG
7. OIL FILTER PLUG
8. NEEDLE VALVE
9. CHOKE LEVER
10. IDLE VALVE
11. AIR CLEANER
12. IDLE SCREW
13. GOVERNOR SCREW
14. SPARK PLUG
15. STOP SWITCH
16. OIL SUMP
17. CYLINDER HEAD
18. CARBURETOR
19. FUEL LINE

TRANSPARENCY VI-1-E

DUST AND SMALL ENGINES


APPROXIMATELY 2 CU. FT. OF CLEAN AIR REQUIRED PER HORSEPOWER

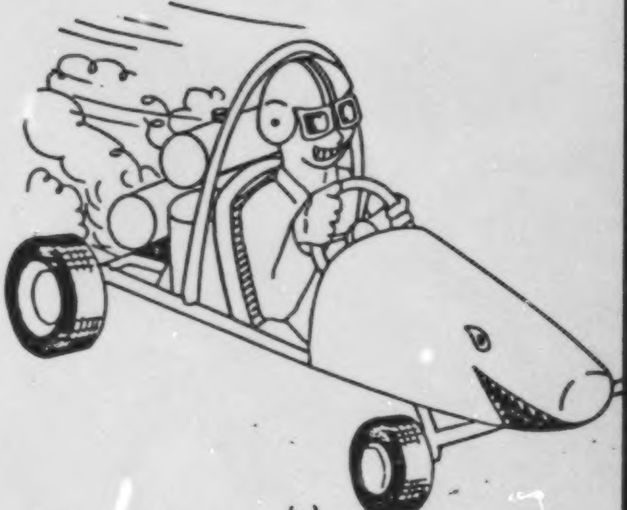
(a)


A DUST MASK IS NECESSARY

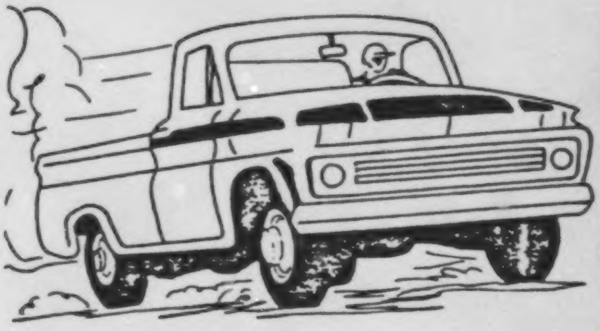
(b)

(A) SMALL ENGINES REQUIRE LARGE AMOUNTS OF AIR - APPROXIMATELY TWO CUBIC FEET PER HORSEPOWER PER MINUTE.

(B) THE AIR MUST BE CLEAN.



(a)



(b)

(A) MANY SMALL ENGINES ARE NEAR THE GROUND WHERE DUST IS THICKEST.

(B) AUTOMOTIVE ENGINES ARE USUALLY SOMEWHAT REMOVED FROM INTENSE DUST.

TRANSPARENCY VI-1-F

OWNER'S ENGINE-INFORMATION FORM

GENERAL INFORMATION:

NAME OF EQUIPMENT (ON WHICH ENGINE IS MOUNTED)

NAME AND ADDRESS OF EQUIPMENT MANUFACTURER

NAME AND ADDRESS OF ENGINE MANUFACTURER

OPERATING POSITION OF CRANKSHAFT: VERTICAL ☐, HORIZONTAL ☐, MULTI-POSITION ☐.

ENGINE CYCLE: 2-Cycle ☐, 4-Cycle ☐.

MODEL NUMBER, OR NAME

SERIAL NUMBER

SPECIFICATION NUMBER

TYPE NUMBER

HORSEPOWER

TYPES OF ACCESSORIES AND MAJOR UNITS:

CARBURETOR AIR CLEANER: Oil bath☐, Oiled filter☐, Dry filter☐.

FUEL STRAINER: Combination screen and sediment bowl☐, Screen inside the fuel tank☐.

CRANKCASE BREATHER: Reed valve☐, Floating disk valve☐.

STARTER: Rope-wind☐, Rope-rewind☐, Wind up☐, Electric, AC☐, Electric, DC☐.

IGNITION SYSTEM: Flywheel magneto☐, External magnet☐, Battery☐.

FUEL PUMP: Mechanically driven☐, Differential pressure driven☐.

CARBURETOR: Float☐, Suction lift☐, Diaphragm☐.

GOVERNOR: Air vane☐, Centrifugal☐.

SERVICE AND MAINTENANCE SPECIFICATIONS:

FUEL: Octane number .... Mixture of oil and gasoline (2-cycle) (Amount of oil per gallon of gasoline): 1/4 pint☐, 1/2 pint☐, other............

OIL: SAE grade: 5 W☐, SAE 10 W☐, SAE 20 W☐, SAE 30☐, SAE 10 W-30☐. Classification: ML☐, MM☐, MS☐.

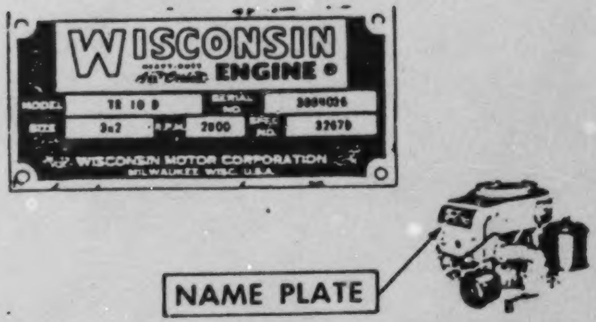
TYPE OF SPARK PLUG: ....

Gap setting: .020", .025", Other ....

IGNITION BREAKER-POINT GAP: .012"☐, .015"☐, Other ....

TRANSPARENCY VI-1-G

INFORMATION FOUND ON THE NAME PLATE

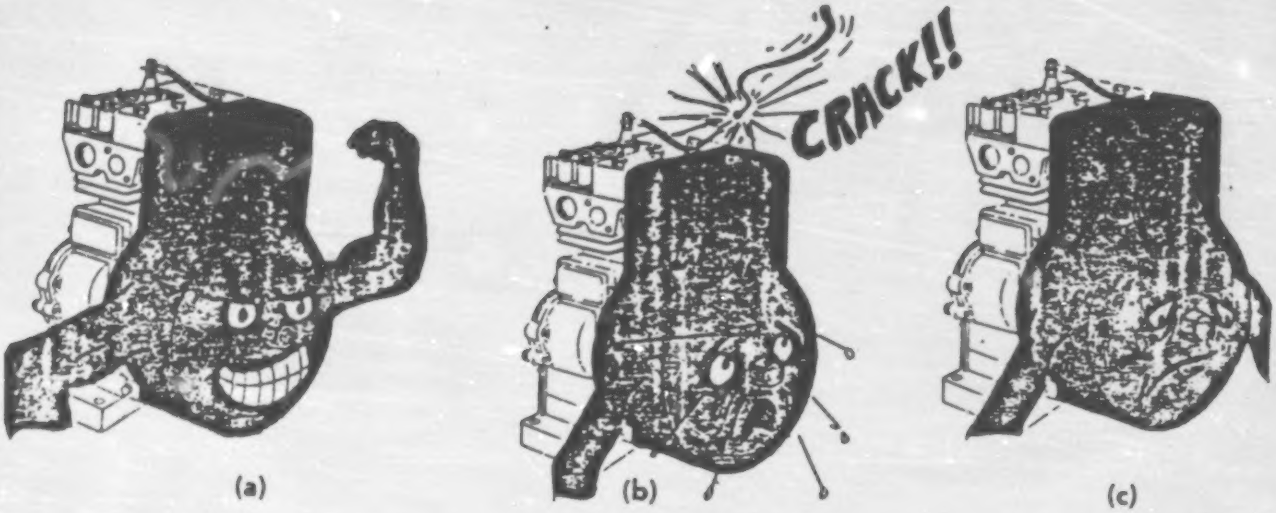

WISCONSIN
HEAVY-DUTY
Air Cooled
ENGINE
MODEL
TR 10 D
SERIAL NO.
3004036
SIZE
3x2
R.P.M.
2800
SPEC. NO.
37670
WISCONSIN MOTOR CORPORATION
MILWAUKEE WISC. U.S.A.
NAME PLATE

The engine name plate gives important information for ordering parts.

1) Model Number
2) Serial Number
3) Size
4) RPM
5) Additional Information
6) Manufacturer

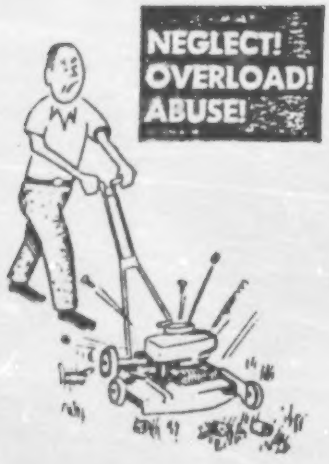
Transparency VI-1-H

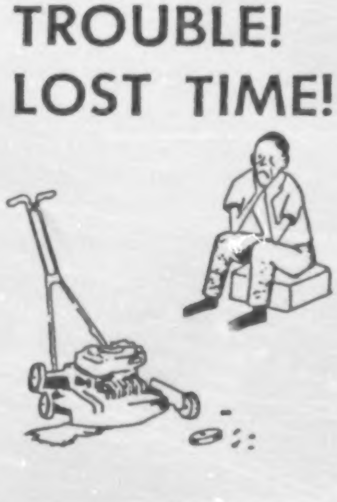
ABUSE AND SMALL ENGINES

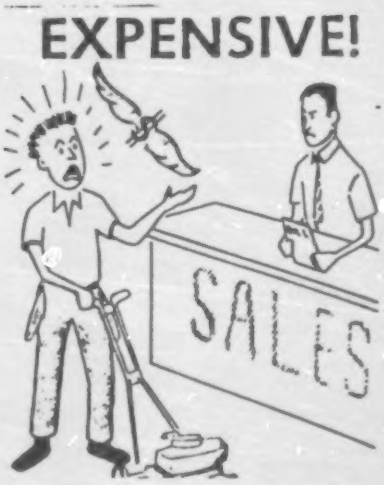


(a) (b) (c)

(A) SMALL ENGINES ARE TOUGH, BUT ABUSE (B) WILL SHORTEN THEIR LIFE (C).

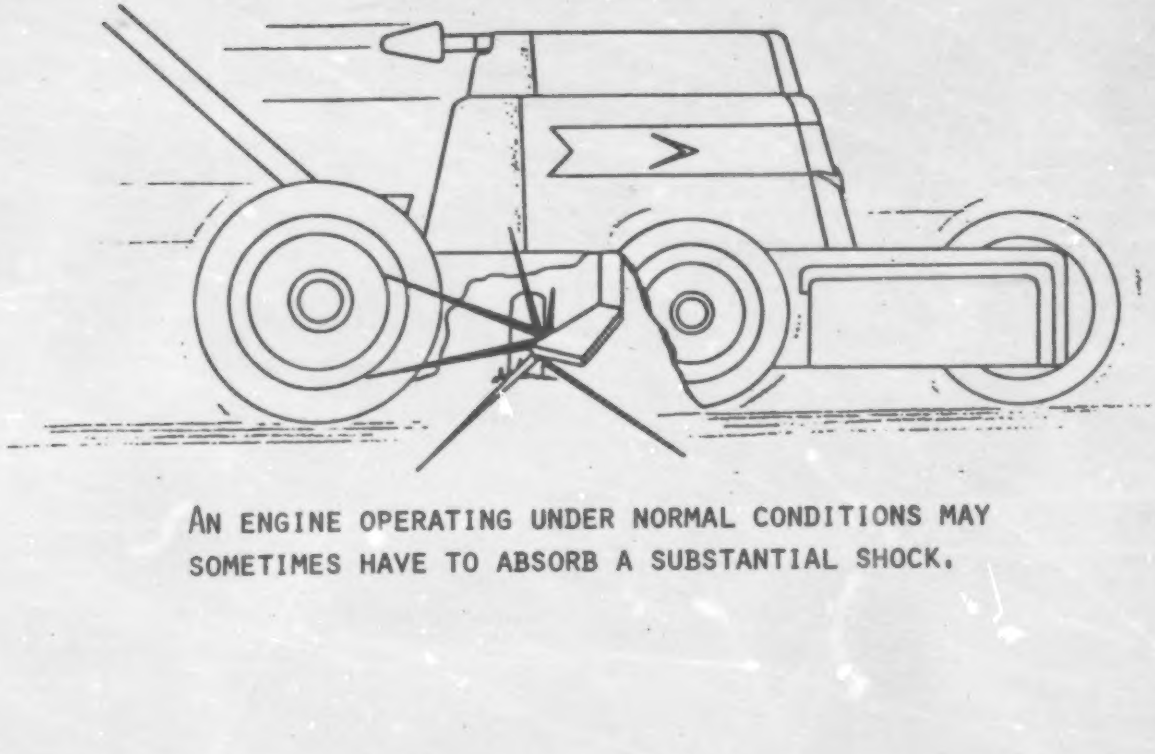

NEGLECT!
OVERLOAD!
ABUSE!


TROUBLE!
LOST TIME!


EXPENSIVE!
SALES

TRANSPARENCY VI-1-I

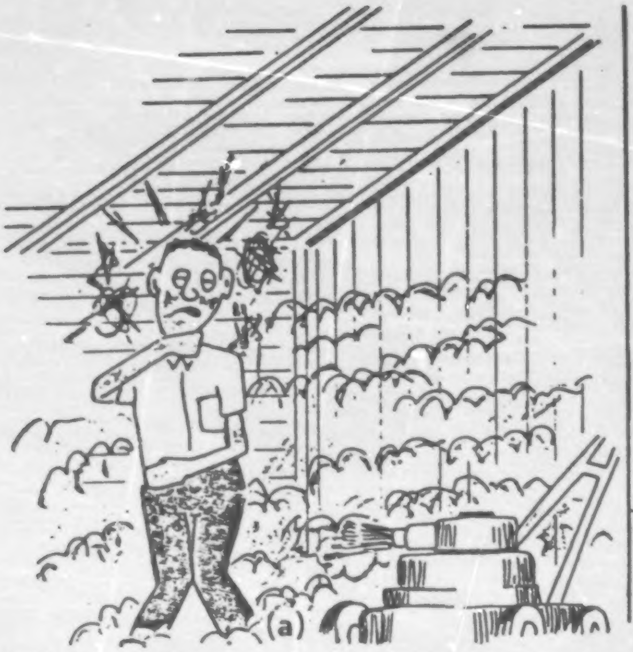
A SUDDEN STOP



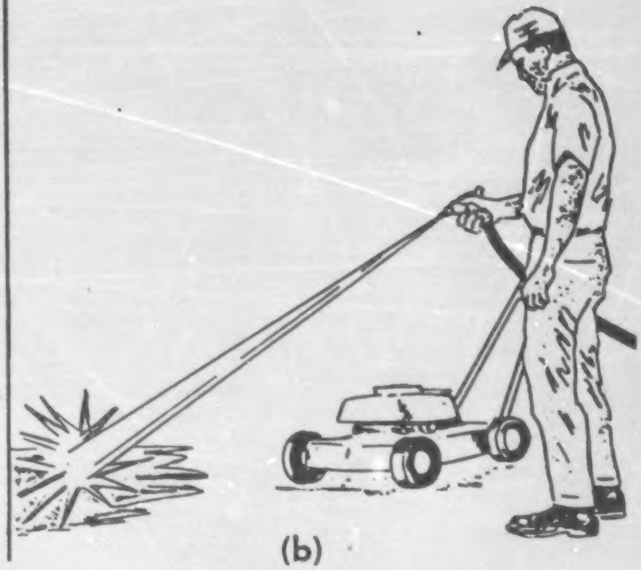
AN ENGINE OPERATING UNDER NORMAL CONDITIONS MAY SOMETIMES HAVE TO ABSORB A SUBSTANTIAL SHOCK.

TRANSPARENCY VI-1-J

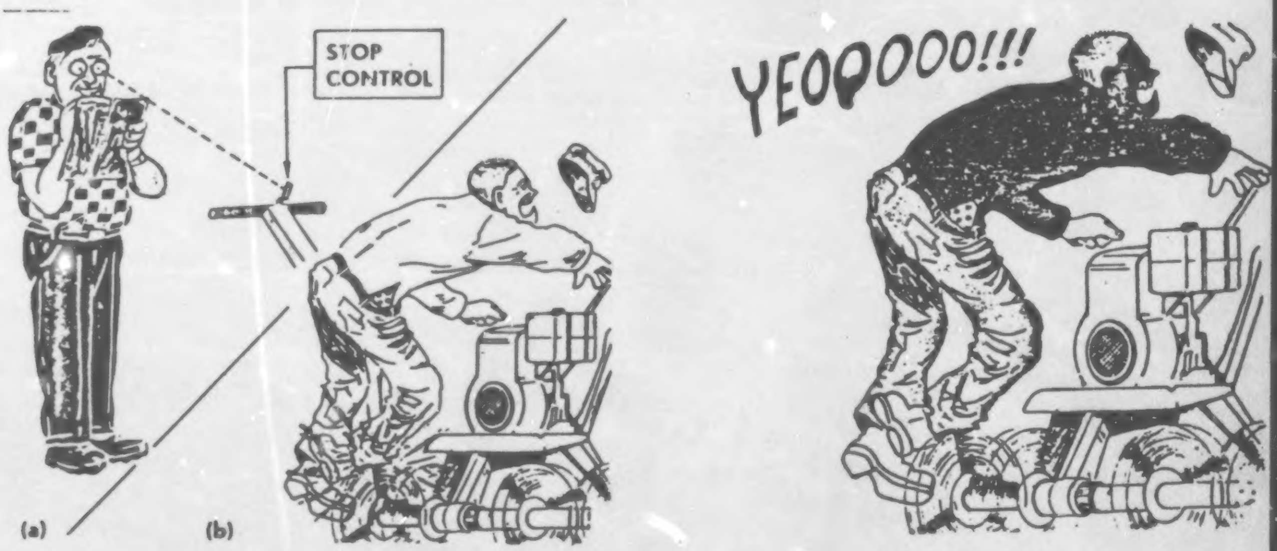
SAFETY AND SMALL ENGINES



(A) Do not operate the engine in a closed area.



(B) Wash spilled gasoline away from a paved surface with water before starting the engine.

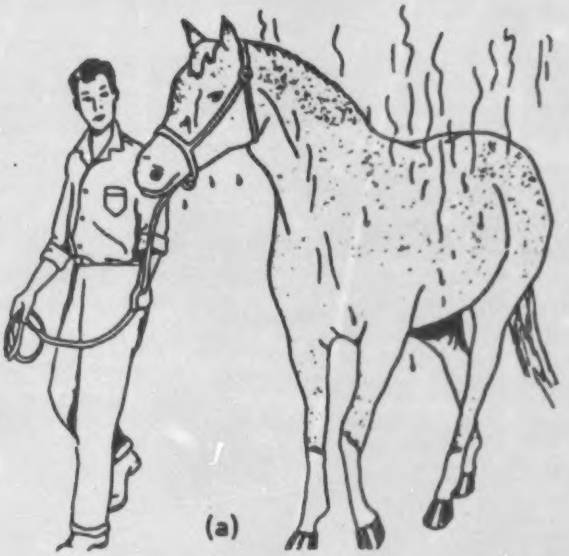


(A) Read your operator's manual.

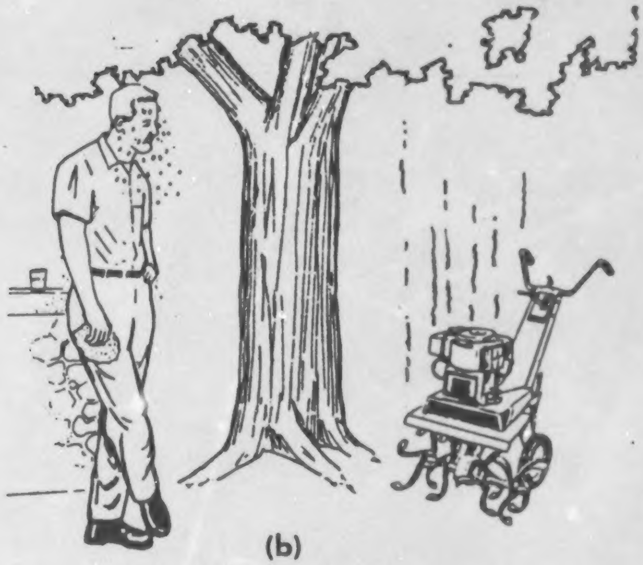
(B) Do not wear loose-fitting clothing around equipment and stay clear of all moving parts while engine is running.

Transparency VI-1-K

COOL DOWN PERIOD



(a)

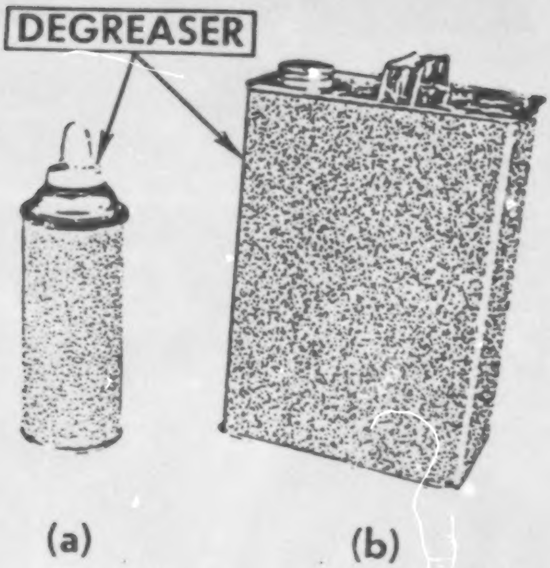


(b)

(A) Horses are walked after a race to allow them to cool down gradually.

(B) For the same reason you should let your engine idle one or two minutes before stopping it.

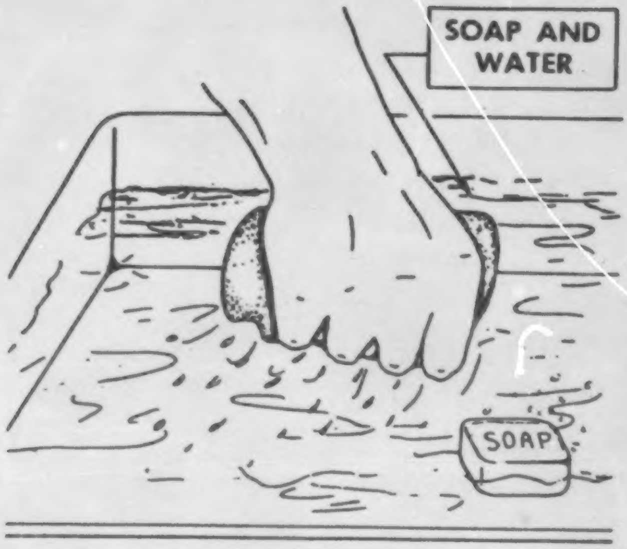
DE-GREASERS ARE AVAILABLE IN...



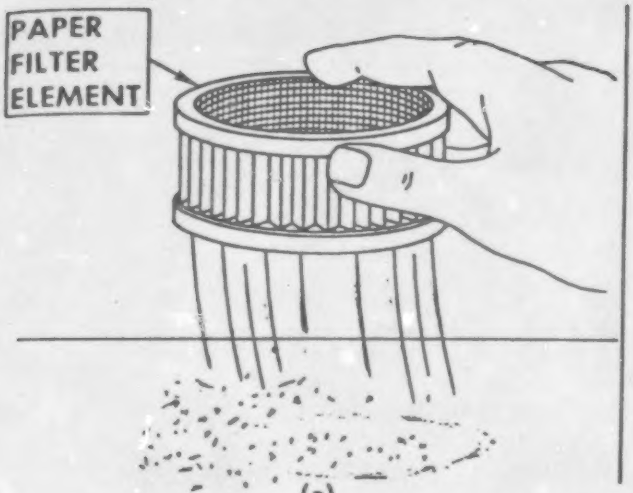
(A) SMALL PRESSURE-TYPE CANS, OR

(B) BULK AS A CONCENTRATE REQUIRING DILUTION BEFORE BEING APPLIED.

CLEANING FILTERS

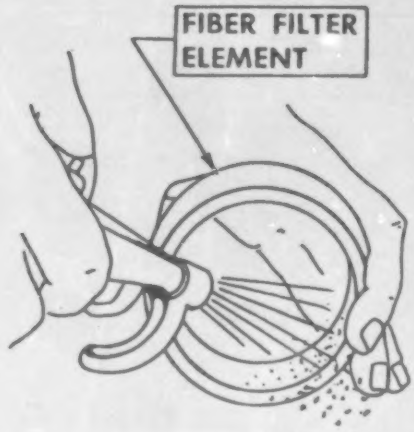

SOAP AND WATER
SOAP

CLEANING A POLYURETHANE FILTER WITH SOAP AND WATER.


PAPER FILTER ELEMENT

(a)

(A) CLEAN PAPER ELEMENT BY TAPPING IT LIGHTLY ON A FLAT, HARD SURFACE.

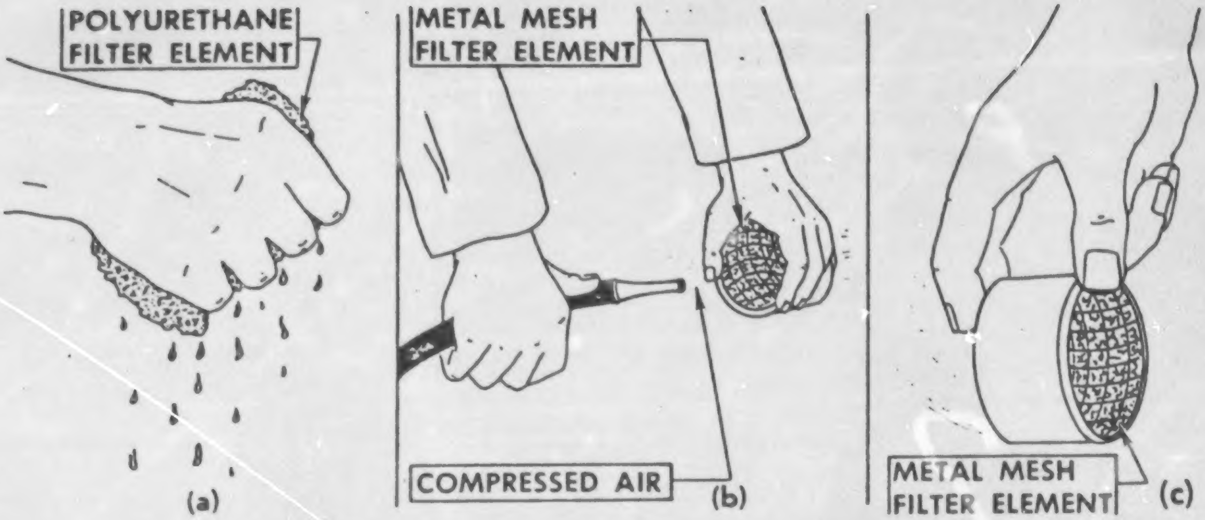

FIBER FILTER ELEMENT

(b)

(B) CLEAN FIBER ELEMENT BY DIRECTING COMPRESSED AIR FROM THE INSIDE OUT.

TRANSPARENCY VI-1-N

DRYING FILTER ELEMENTS


POLYURETHANE FILTER ELEMENT
(a)
METAL MESH FILTER ELEMENT
COMPRESSED AIR
(b)
METAL MESH FILTER ELEMENT
(c)

(A) DRY POLYURETHANE FILTER BY SQUEEZING

(B) DRY METAL MESH BY COMPRESSED AIR OR BY

(C) SWISHING

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VII: Arc Welding

LESSON 1: Fundamentals in Arc Welding

I. Preparation for Instruction

   A. Student Objectives

      1. Terminal: Identify fundamental procedures and equipment for arc welding and demonstrate basic arc welding skills.

      2. Specific:

         a. Define arc welding.
         b. List and describe the equipment that is necessary to arc weld.
         c. State the basic safety rules in arc welding.
         d. List substances that should be removed from metal before it is welded.
         e. List the four basic positions used in arc welding.
         f. List the four basic joints used in arc welding.
         g. Describe how to start the arc.
         h. List the factors in determining the proper current setting of the machine.
         i. Describe the sound of a proper arc.
         j. Define travel speed.
         k. Define a crater.
         l. Describe the proper procedure to follow to ensure that a crater, from a previous weld, is filled.
         m. State the two procedures used to break the arc.
         n. Define lead and work angles.
         o. Define multiple pass welds.
         p. Describe the advantages of weaving an electrode.
         q. Explain the factors to consider in determining electrode selection.
         r. List the five main ways that electrodes are classified.

s. Explain the electrode identification system.
t. Contrast fast-freeze, fill-freeze, and fast fill electrodes.
u. Describe importance of keeping electrodes dry.
v. Describe arc welding difficulties, their causes, and their remedies.
w.

x.

y.

B. Review of Teaching Materials

1. Phipps, L.S. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

2. McCoy, V.L. and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

Arc welders and welding equipment (gloves, electrodes, helmets, chipping hammers, wire brushes, aprons, etc.)

D. Materials Required

1. Overhead projector and screen

2. Materials listed above

II. Presentation of Lesson

A. Motivation

1. To become a successful welder, an individual needs to become familiar with the terms used in welding, to have a basic understanding of the hows and whys of a welder, and to know what good workmanship looks like in a weld.

2. The following is a list of a few of the advantages in becoming a proficient welder:

a. Saves time,

b. Reduces cost of expensive repairs,

c. Allows an individual the opportunity to make metal projects for home or farm use,

d. Gives a feeling of pride and self-satisfaction for doing a good job,

e. Promotes the ability to recognize machinery and equipment that is well manufactured and to have an appreciation for it.

B. Content Outline

1. Arc welding is a melting together of two pieces of metal or a fusion process. The heat obtained from an electric arc is formed between a base metal and an electrode. An electrode is shaped like a wire or rod and held in an electrode holder which is attached to an electric arc welder. When this electrode is properly brought into contact with the metal to be welded, an electric arc is formed. The heat of this arc, which is approximately 6,500 degrees Fahrenheit, fuses the metal being welded and melts the electrode or filler metal.

   The electrode carries the current to form the arc (hence its name) and also produces a gas which shields the arc from the atmosphere, and adds metal to form the weld shape. (Transparency VII-1-A)

   When an arc is struck using a coated electrode, the intense heat melts the tip of the electrode. The tiny drops of metal from the electrode enter the arc stream and are desposited on the base metal. As the metal is deposited, a slag forms over the weld which insulates it against the contaminants of the air while it cools.

2. The following equipment is needed for electric arc welding:

   a. Power supply,

   b. Electrode holder,

   c. Ground clamp,

   d. Protective shield, and

   e. Welder's clothing.

   A summary of each of the above mentioned pieces of equipment is listed below:

   a. Power supply -- for effective arc welding, a constant current is required. The welding machine must have a drooping volt-ampere curve in which a relative constant supply of current is produced with only a limited change in voltage load.

In other electrical appliances the demand for current usually remains fairly constant, but in arc welding the power fluctuates a great deal. Thus, when the arc is struck with the electrode a short circuit results which immediately induces a sudden surge of electrical current unless the machine is designed to prevent this. Similarly, when molten globules of weld metal are carried across the arc stream, they also create a short circuit. A constant-current power supply is designed to reduce these sudden surges of short circuits and so prevent excessive spattering during welding.

In arc welding the open-circuit voltage (voltage when the machine is running and no welding is being done) is much higher than the arc voltage (voltage after the arc is struck). The open-circuit voltage may vary from 50 to 100 and the arc voltage 18 to 36. During the welding process the arc voltage will also change with differences in arc length.

Since it is difficult for even a skilled operator to maintain a uniform arc length at all times, a machine with a steep volt-ampere curve will produce a more stable arc, because there will be almost no change in welding current even with changes in arc voltage. A volt-ampere curve shows the output voltage available at any given output current within the limits of the minimum and maximum current control setting on each range.

For example, the curve in Transparency VII-1-B indicates that a high open circuit voltage is available at 0 which helps in starting the arc. As welding proceeds, the voltage drops to the arc voltage at A and at this point fluctuation in the arc length will hardly affect the current. If the electrode is short circuited on the work, the current will not become excessive, as indicated at B.

The current used directly affects the melting rate. As the rate of current is increased, the current density at the electrode tip also is increased. The amount of current required for any welding operation is governed by the thickness of the work metal. This current is controlled by a wheel or lever arrangement. One control sets the machine for an approximate current setting and another control provides a more accurate current adjustment.

1) Three basic welding machines used in arc welding:

    a) Generators -- usually direct current

        The direct-current power supply consists of a generator driven by an electric motor or a gasoline engine. (Transparency VII-1-C)

        One of the characteristics of a direct-current welding generator is that the welding can be done with straight or reverse polarity. Polarity indicates the direction of current flow in a circuit. In straight polarity, the electrode is negative and the workpiece positive and the electrons flow from the electrode to the workpiece (Transparency VII-1-D). In reverse polarity, the electrode is positive and the workpiece negative and the electrons flow from the workpiece to the electrode.

        Polarity is changed by switching cables, although on modern machines changing polarity is done by simply turning a switch.

Polarity affects the liberated heat since it is possible to control the amount of heat going into the base metal. By changing polarity, the welder can concentrate the greatest heat where it is most needed.

Usually it is preferable to have more heat at the workpiece because the area of the work is greater and more heat is required to melt the metal than the electrode. Thus, if large heavy deposits are to be made, the work should be hotter than the electrode. For this purpose, straight polarity is more effective.

On the other hand, in overhead welding it is necessary to quickly freeze the filler metal to help hold the molten metal in position against the force of gravity. By using reverse polarity, less heat is generated at the workpiece, giving the filler metal greater holding power for out-of-position welding.

In other situations, it may be better to keep the workpiece as cool as possible, as in repairing a cast-iron casting. With reverse polarity, less heat is produced in the base metal and more heat at the electrode. The result is that the deposits can be applied rapidly while the base metal is prevented from overheating.

b) Transformers -- for alternating current

The transformer welding machine produces alternating current. Power is taken directly from a power supply line and transformed into a voltage required for welding. (Transparency IV-1-E)

The simplest AC transformer has a primary and a secondary coil with an adjustment to regulate the current output. The primary coil receives the alternating current from the source of supply and creates a magnetic field which constantly changes in direction and strength. The secondary coil has no electrical connection to the power source but it is affected by the changing lines of force in the magnetic field. Through induction it delivers a transformed current at a higher value to the welding arc.

Some AC transformers are equipped with an arc booster switch which supplies a burst of current for easy arc starting when the electrode comes in contact with the work. After the arc is struck, the current automatically returns to the amount set for the job. The arc booster switch has several settings to permit quick arc starting for welding either thin sheets or heavy plates.

One advantage of the AC welding machine is freedom from arc blow that often occurs when welding with DC machines. Arc blow causes the arc to wander while welding in corners on heavy metal or when using large coated electrodes. Direct current flowing through the electrode, workpiece, and ground clamp generates a magnetic field around each of these units that may cause the arc to deviate from its intended path. The arc usually is deflected either forward or backward along the line of travel and may cause excessive spatter and incomplete fusion. It also tends to pull atmospheric gases into the arc, resulting in porosity. The bending of the arc is due to the effects of an unbalanced magnetic field. Thus when a great concentration of magnetic flux develops on one side of the arc it tends to blow away from the source of greatest concentration.

Arc blow can often be corrected by changing the position of the ground clamp, welding away from the ground clamp, or changing the position of the weldpiece on the workbench.

c) Rectifiers -- choice of currents

Rectifiers are transformers which contain an electrical device changing alternating current into direct current.

The rectifiers for arc welding are usually of the constant-current type where the welding current remains reasonably constant for small variations in arc length.

Rectifiers are made to provide DC current only, or both DC and AC welding currents (Transparency VII-1-F). By means of a switch, the output terminals can be changed to the transformer or to the rectifier, producing either AC current or DC straight or DC reverse polarity current.

At present, the two rectifier materials used for welding machines are selenium and silicon. Both are excellent, although silicon will often permit operation at higher current densities. 221

2) Welding machines are sized according to their output rating, which may range from 150 to 600 amperes.

The output rating is based on a 60 percent duty cycle. This means that a power supply can deliver its rated load output for six minutes out of every 10 minutes. In manual welding, a power source is not required to provide current continuously, as on other electrical machines. For some electrical devices, once the power is turned on it must deliver its rated output until it is shut off. With a welding power supply, the machine is often idle part of the time while the operator changes electrodes, adjusts the work, or shifts welding positions. Thus the standard method of rating a machine is to show the percentage of time that it must actually deliver power. For this reason, fully automatic power supply units are usually rated at 100 percent duty cycle.

The size of welding machine used depends on the kind and amount of welding to be done. The following is a general guide for selecting a welding machine.

150-200 ampere -- For light-to medium-duty welding. Excellent for all fabrication and rugged enough for continuous operation on light or medium production work.

250-300 ampere -- For average welding requirements. Used in plants for production, maintenance, repair, toolroom work, and all general shop welding.

400-600 ampere -- For large and heavy-duty welding. Especially good for structural work, fabricating heavy machine parts, pipe and tank welding.

b. Electrode Holder -- The electrode holder (Transparency VII-1-G) is used to hold the electrode and guide it over the seam to be welded. A good holder should be light to reduce excessive fatigue while welding, receive and eject electrodes easily, and be properly insulated. Some holders are fully insulated, while in others only the handle is insulated.

When using a holder with uninsulated jaws, never lay it on the bench plate while the machine is running because it will cause a flash.

Always connect holders firmly to the cable. A loose connection where the cable joins the holder may overheat the holder.

The use of large enough cable is also necessary for proper welding. A 30-ft. lead cable of a given size may be satisfactory to carry the required current, but if another 30 ft. of cable is added, the combined resistance of the two leads reduces the current output of the machine. If the machine is then readjusted for a higher output, the additional load may cause the power supply to overheat and increase its power consumption.

The primary cable which connects the welding machine to the source of electricity is also significant. The length of this cable has been determined by the manufacturer of the power supply unit and represents a length that permits the machine to operate efficiently without an appreciable drop in voltage. If a longer cable is used, more voltage will be required for the work to be done, and if no more voltage is available, the resulting voltage drop will seriously affect the welding.

c. Ground Clamp -- The ground clamp is vital to an electrical welding outfit. Without proper grounding, the full potential of the circuit will fail to provide the required heat for welding.

A good ground connection can be made in several ways. The ground cable may be fastened to the work bench by a C-clamp, a special ground clamp, or by bolting or welding a lug on the end of the cable to the bench. (Transparency VII-1-H)

d. Protective Shield -- A suitable helmet or handshield is required for all arc welding. An electric arc produces a brilliant light and gives off invisible ultraviolet and infrared rays which can burn the eyes and skin. Never look at the arc with the naked eye within a distance of 50 feet.

Both the helmet and handshield are equipped with special colored lenses that reduce the brilliancy of the light and screen out the infrared and ultraviolet rays.

Lens come in different shades for various welding. In general, the recommended practice is as follows:

Shade 5 -- For light spot welding
Shade 6 and 7 -- For welding up to 30 amps

Shade 8 -- For welding 30 to 75 amps
Shade 10 -- For welding 75 to 200 amps
Shade 12 -- For welding 200 to 400 amps
Shade 14 -- For welding over 400 amps

e. Welder's Clothing -- The welder in Transparency IV-1-I is fully clothed for welding safety.

Gloves should be heavy-duty with long cuffs. Regulation leather welding gloves should be available. Use asbestos gloves when working in intense heat; however, use clamps, not gloves, to pick up hot metal.

Leather sleeves give extra protection from sparks and intense heat.

Leather or asbestos aprons are recommended for heavy welding and cutting.

Wear heavy shoes and never roll the pant leg as molten metal may fall into them. If possible, remove or cover pockets in front of trousers or shirts.

Cover the head with a protective cap and always keep the protective shield in place.

3. Before starting to weld, observe all rules for safety.

Safety Rules -- Observe all safety precautions. Here are the basic rules:

a. Be sure the welding area has a cement or masonry floor.

b. Keep all combustible materials at a safe distance.

c. Do not use gloves or other clothing which contain oil or grease.

d. Be sure all power wiring is correctly installed and maintained. Don't overload the welding cables.

   e. Always be sure your machine is properly grounded. Never work in a damp area.

   f. Shut off the welding machine before making repairs or adjustments to avoid shocks.

   g. Follow the manufacturer's rules on operating the switches and making other adjustments.

   h. Protect others with a screen and yourself with a protective shield. Flying sparks are a danger to your eyes. Arc rays can also cause painful burns.

   i. Keep firefighting equipment handy at all times.

4. Clean all rust, scale, paint, or dirt from metal joints to be welded. Also be sure the metals are free of oil.

5. Arc welding can be done in any of the four basic positions as shown in Transparency VII-1-J.

   a. Horizontal

   b. Flat

   c. Vertical

   d. Overhead

   The flat position is generally easier and faster, plus giving better penetration.

6. The basic types of joints used in joining metal products are illustrated in Transparency VII-1-K.

   The four basic joints used in arc welding are:

   a. Butt joints,

   b. Tee joints,

   c. Lap joints, and

d. Corner joints

A closed butt joint has the edges of the two plates in direct contact with each other. This joint is suitable for welding steel plates that do not exceed 1/8 to 3/16 inch in thickness. Heavier metal can be welded but only if the machine has sufficient amperage capacity and if heavier electrodes are used.

The open butt joint has the edges slightly apart to provide for better penetration. Very often a backup bar of steel, copper, or brick is placed under an open joint to prevent the bottom edges from burning through.

When the thickness of metal exceeds 1/8 or 3/16 inch, the edges have to be bevelled for better penetration.

Beveling may be confined to one plate or the edges of both plates are bevelled, depending on the thickness of the metal. Angle of bevel is usually 60 degrees between the two plates.

7. To start the arc, tap or scratch the electrode on the work (Transparency VII-1-L). As soon as the arc is started, immediately raise the electrode a distance equal to the diameter of the electrode. Failure to raise the electrode causes it to stick to the metal. If it is allowed to remain in this position with the current flowing, the electrode will become red hot.

   When an electrode does stick, it can be broken loose by quickly twisting or bending it. If it does not dislodge, release the electrode from the holder.

8. The amount of current to be used depends upon:

   a. The thickness of the metal to be welded,

   b. The actual position of welding, and

   c. The diameter of the electrode.

As a rule, higher currents and larger diameter electrodes can be used for welding in flat and vertical positions or overhead welding.

Electrode diameter is governed by the thickness of the plate and welding position. For most flat position welding, the electrodes should be 5/16 or 3/8 inch maximum, while 3/16 should be the maximum for vertical and overhead welding.

Manufacturers of electrodes generally specify a range of current values for various diameter electrodes. However, since the recommended current setting is only approximate, final current adjustment is made during welding.

For example, if the current range for an electrode is 90-100 amperes, the usual practice is to set the control midway between the two limits. After starting to weld, make a final adjustment by either increasing or decreasing the current.

Whenever the current is too high, the electrode will melt too fast and the molten puddle will be too large and irregular.

When the current is too low, there will not be enough heat to melt the base metal and the molten pool will be too small. The result is not only poor fusion but also the deposit will pile up and be irregular in shape. (Transparency VII-1-M)

Too high a current may also produce undercutting, (Transparency VII-1-N) which leaves a groove in the base metal along both sides of the bead.

A current that is set too low will cause overlaps to form where the molten metal from the electrode falls on the work without sufficiently penetrating the base metal. Both undercutting and overlapping result in weak welds.

9. If the arc is too long the metal melts off the electrode in large globules that wobble from side to side as the arc wavers.

This produced a wide, spattered, and irregular deposit without sufficient fusion between the original metal and the deposited metal. 228

An arc that is too short fails to generate sufficient heat to melt the base metal properly. Also, the electrode will stick frequently and produce uneven deposits with irregular ripples.

The length of the arc depends on the type of electrode used and the kind of welding done. Thus, for small diameter electrodes, a shorter arc is necessary as compared to the larger electrodes. Generally, the length of the arc should be approximately equal to the diameter of the electrode.

A shorter arc is usually better for vertical and overhead welding because better control of the molten puddle is achieved.

The use of a short arc also prevents impurities from the atmosphere entering the weld. A long arc allows the atmosphere to flow into the arc stream, permitting nitrides and oxides to form. Moreover, when the arc is too long, heat from the arc stream is dissipated too rapidly, causing considerable metal spatter.

When the electrode, current, and polarity are correct, a good short arc will produce a sharp, crackling sound. A long arc can be recognized by a steady hiss very much like escaping steam.

10. Travel speed is the rate the electrode travels along the weld seam. The maximum speed of welding is influenced by the skill of the operator, the position of the weld, the type of electrode, and the required joint penetration.

    Normally, if the speed is too fast, the molten pool does not last long enough and impurities become locked in the weld. The weld bead usually is narrow with pointed ripples. (Transparency VII-1-M)

On the other hand, if the travel is too slow, the metal piles up excessively and the weld bead is high and wide. (Transparency VII-1-M) 229

In most cases, the limiting speed is the highest speed that produces a satisfactory surface appearance.

11. As the arc comes in contact with the base metal, a pool or pocket is formed which is called a crater. The size and depth of a crater indicated the amount of penetration. In general, the depth of penetration should be from one-third to one-half the total thickness of the weld bead depending upon the size of the electrode.

    For a sound weld, the metal deposited from the electrode must fuse completely with the base metal. Fusion will result only when the base metal has been heated to a liquid state and the molten metal from the electrode readily flows into it. Thus if the arc is too short there will be insufficient spread of heat, or if the arc is too long the heat is not centralized enough to form the desired crater. An improperly filled crater may cause a weld to fail when a load is applied to the welded structure.

12. When starting an electrode, there is always a tendency for a large globule of metal to fall on the surface of the plate with little or no penetration. This is especially true when beginning a new electrode at the crater left from a previously deposited weld. To ensure that the crater is filled, the arc should be struck approximately ½ inch in front of the crater. The arc should then be brought through the crater to a point beyond the crater and then the weld carried back through the crater.

13. When the electrode reaches the end of a seam, make sure that the crater is filled. This means breaking the arc at the right moment.

    Two procedures used to break the arc for a full crater:

a. Shorten the arc and move the electrode quickly sideways out of the crater.

b. Hold the electrode stationary just long enough to fill the crater and then gradually withdraw from it.

Occasionally, the crater may become too hot and the molten metal will run. When this happens, lift the electrode and shift it quickly to the side or ahead of the crater. This movement reduces the heat, allows the crater to solidify momentarily, and stops the deposit of metal from the electrode.

14. The angular position of the electrode has a direct influence in the quality of the weld. Often the position of the electrode determines the ease with which the filler metal is deposited, prevents undercutting and slag, and keeps the weld contour uniform.

The two prime factors in electrode position are lead angle and work angle.

a. Lead Angle -- is the angle between the joint and the electrode when viewed in a longitudinal plane. (Transparency VII-1-0)

b. Work Angle -- is the angle between the electrode and the work when viewed from an end plane. (Transparency VII-1-0)

Some of the basic electrode positions for flat, horizontal, vertical, and overhead welding are illustrated in Transparency VII-1-J.

15. A single pass weld involves depositing one layer of weld metal. In welding light materials, a single pass is usually sufficient.

On heavier plates and where added strength is required, two or more layers are required with each weld pass lapping over the other. (Transparency VII-1-Q)

Whenever a multiple pass is used, the slag on each weld bead must be removed completely before the next layer is deposited.

16. Weaving is a technique used to increase the width and volume of the weld deposit. Enlarging the size of the weld deposit is often necessary on deep grooves or fillet welds where a number of passes must be made. Transparency VII-1-R illustrates several weaving patterns. The patterns used depend to a large extent on the position of the weld.

17. The type of electrode selected for arc welding depends upon:

    a. Quality of weld required,

    b. Weld position,

    c. Joint design,

    d. Welding speed, and

    e. Composition of base metal.

18. All electrodes,in general, are classified into five main groups: mild steel, high carbon steel, special alloy steel, cast iron, and nonferrous. The greatest range of arc welding is done with electrodes in the mild steel group.

    Electrodes are manufactured to weld different metals and are also designed for DC straight and reverse polarity or AC welding. A few electrodes work equally well on either DC or AC. Some electrodes are best suited for flat position welding, others are intended for vertical and overhead welding, and some are used in any position.

    The shielded electrode has a heavy coating of several chemicals such as cellulose, titanimum dioxide, ferro-manganese, cilica flour, calcium carbonate, and others. These ingredients are bound together with sodium silicate.

    Each of the substances in the coating is intended to serve a particular function in the welding process. In general, their main purposes are to induce easier arc starting, stabilize the arc, improve weld appearance and penetration, reduce spatter, and protect the molten metal from oxidation or contamination by the surrounding atmosphere.

Molten metal as it is deposited in the welding process is attracted to oxygen and nitrogen. Since the arc stream takes place in an atmosphere consisting largely of these two elements, oxidation occurs while the metal passes from the electrode to the work. When this happens, the strength and ductility of the weld are reduced as well as its resistance to corrosion. The coating on the electrode prevents oxidation from taking place. As the electrode melts, the heavy coating releases an inert gas around the molten metal which excludes the atmosphere from the weld. (Transparency VII-1-S)

The burning residue of the coating forms a slag over the deposited metal which slows down the rate of cooling and produces a more ductile weld.

Some coatings include powdered iron that is converted to steel by the intense heat of the arc and flows into the weld deposit.

19. Electrodes are often referred to by a manufacturer's trade name. To ensure some degree of uniformity in manufacturing electrodes, the American Welding Society (AWS) and the American Society for Testing Materials (ASTM) have set up certain requirements for electrodes. Thus, different manufacturer's electrodes which are within the classification established by the AWS and ASTM may be expected to have the same welding characteristics.

In this classification, each type of electrode has been assigned specific symbols such as E-6010, E-7010, E-8010, etc. The prefix "E" identifies the electrode for electric arc welding. The first two digits in the symbol designate the minimum allowable tensile strength of the deposited weld metal in thousands of pounds per square inch.

For example, the 60 series electrodes have a minimum pull strength of 60,000 pounds per square inch; the 70 series, a strength of 70,000 pounds per square inch. 233

The third digit of the symbol indicates possible welding positions. Three numbers are used for this purpose: 1, 2, and 3. Number 1 is for an electrode which can be used for welding in any position. Number 2 represents an electrode restricted for welding in horizontal and flat positions. Number 3 represents an electrode to be used in the flat position only.

The fourth digit of the symbol simply shows some special characteristic of the electrode such as weld quality, type of current, and amount of penetration.

20. Several factors are vital when choosing an electrode for welding. The welding position is particularly significant.

As a rule, never use an electrode which has a diameter larger than the thickness of the metal to be welded. Some operators prefer larger electrodes because they permit faster travel along the joint and thus speed up welding, but this takes a lot of skill.

Position and the type of joint are also factors in determining the size of the electrode. For example, in a thick metal section with a narrow vee, a small diameter electrode is always used to run the first weld or root pass. This is done to ensure full penetration at the root of the weld. Successive passes are then made with larger electrodes.

For vertical and overhead welding, 3/16 inch is the largest diameter electrode that should be used, regardless of plate thickness. Larger electrodes make it too difficult to control the deposited metal.

For economy, always use the largest electrode that is practical for the work. It takes about half the time to deposit a quantity of weld metal from 1/4 inch coated mild steel electrodes than from 3/16 inch electrodes of the same type. The larger sizes not only allow the use of higher currents but require fewer stops to change the electrode.

Deposition rate and joint preparation are also important factors that influence the selection of electrode. Electrodes for welding mild steel are sometimes classified as fast-freeze, fill-freeze, and fast-fill. Fast-freeze electrodes produce a snappy, deep penetrating arc and fast-freezing deposits. They are commonly called reverse-polarity electrodes even though some can be used for AC. These electrodes have little slag and produce flat beads. They are widely used for all-position welding for both fabrication and repair work.

Fill-freeze electrodes have a moderately forceful arc and deposit rate between those of the fast-freeze and fast-fill electrodes. They are commonly called the "straight-polarity" electrodes even though they may be used on AC. These electrodes have complete slap coverage and weld deposits with distinct, even ripples. They are the general-purpose electrode for production shop and are also widely used for repair work. They can be used in all positions, though fast-freeze electrodes are preferred for vertical and overhead welding.

The fast-fill group includes the heavy coated, iron powder electrodes with soft arc and fast deposit rate. These electrodes have a heavy slag and produce exceptionally smooth weld deposits. They are generally used for production welding where all work can be positioned for downhand (flat) welding.

Another group of electrodes are the low-hydrogen type which contain little hydrogen in either moisture or chemical form. These electrodes have outstanding crack resistance, little or no porosity, and quality x-ray deposits.

Welding stainless steel requires an electrode containing chrominum and nickel. All stainless steels have low thermal conductivity. In electrodes, this causes overheating and improper arc action when high currents are used. In base metal, it causes large temperature differences between weld and the rest of the work, which warps the plate. A basic rule in welding stainless steel is to avoid high currents and high heat in the weld. Another reason for keeping the weld cool is to avoid carbon corrosion.

There are also many special-purpose electrodes for surfacing, welding copper and copper alloys, aluminum, cast iron, manganese, nickel alloys, and nickel-manganese steels. Composition of the electrodes is usually designed to match the base metal to be welded.

The basic rule in selecting electrodes is to pick one which is as close to the base metal as possible.

21. Keep electrodes in the sealed container until ready to use them. Air and moisture in the air will combine with chemicals in the electrode covering under most conditions.

The moisture turns to steam as the electrode is heated and hydrogen in the water combines with chemicals in the covering. When mixed with the molten metal, this changes the composition of the weld, which will weaken it.

In summary, keep your electrodes dry.

22. Arc Welding Difficulties

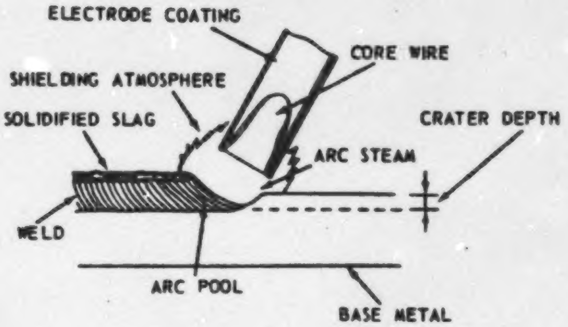
Symptoms	Causes	Remedies
Unstable arc, moves around, arc goes out. Spatter spread over work.	Arc to long.	Shorten arc for proper penetration
No penetration of the weld. Arc goes out often.	Too little current for size of electrode.	Increase current. Use smaller electrode.
Loud cracking sound from arc. Flux melts too rapidly. Bead wide and thin. Spatter in large drops.	Too much current for size of electrode. Could also be moisture in electrode covering.	Decrease current. Use larger electrode.
Weld remains in balls. Poor weld.	Wrong electrode for the work.	Use proper electrode for metal to be welded.
Difficulty in striking the arc. Poor penetration making a poor weld.	Wrong polarity at electrode holder. Uncleaned metal. Too little current.	Change polarity, or use AC instead of DC current. Or, increase current.
Weak weld. Arc hard to make. Arc always breaking.	Work not clean.	Clean work. Remove all slag from previous weld.
Intermittent arc. May cause arcing at the ground clamp.	Poor ground.	Correct the poor ground. Slow down electrode movement.

C. Suggested Student Activities

1. Have the students make a "check list" for the welders and equipment (including safety equipment) that should be checked before beginning to weld.

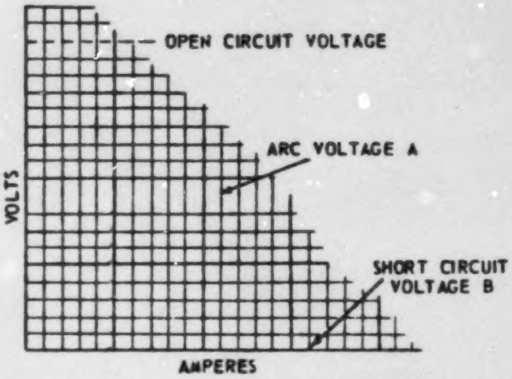
2. Have students look at several arc welding exercises. Ask them to describe or show good welds, average welds, and some bad welds. Upon close examination of the bad welds, ask them to list possible causes and what could have been done to correct the mistakes.

THE ARC WELDING ELECTRODE


ELECTRODE COATING
CORE WIRE
SHIELDING ATMOSPHERE
SOLIDIFIED SLAG
CRATER DEPTH
ARC STEAM
WELD
ARC POOL
BASE METAL

THE ELECTRODE CARRIES THE CURRENT TO FORM THE ARC AND ALSO PRODUCES A GAS WHICH SHIELDS THE ARC FROM THE ATMOSPHERE, AND ADDS METAL TO FORM THE WELD SHAPE.

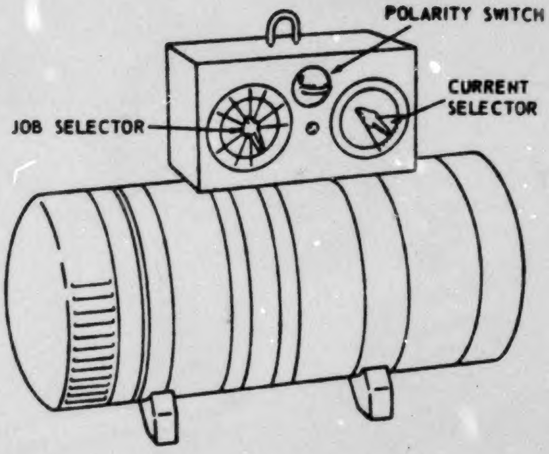
VOLTAGE CURVE



HIGH OPEN CIRCUIT VOLTAGE --- = 0, WHICH AIDS IN STARTING THE ARC. AS WELDING PROCEEDS VOLTAGE DROPS TO THE ARC VOLTAGE AT A. IF ELECTRODE IS SHORT CIRCUITED ON THE WORK, THE CURRENT WILL NOT BECOME EXCESSIVE AT POINT B.

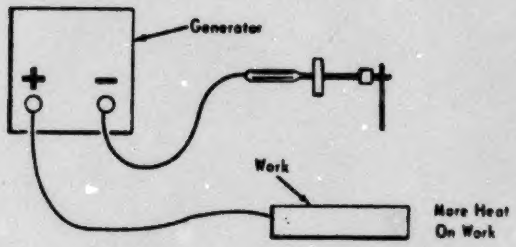
TRANSPARENCY VII-1-B

DIRECT CURRENT POWER SUPPLY

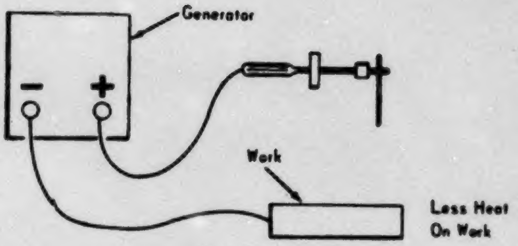

POLARITY SWITCH
CURRENT SELECTOR
JOB SELECTOR

A GENERATOR DRIVEN BY EITHER A GASOLINE OR AN ELECTRIC MOTOR

DCSP AND DCRP


Generator
+
−
Work
More Heat On Work

STRAIGHT POLARITY (DCSP)


Generator
−
+
Work
Less Heat On Work

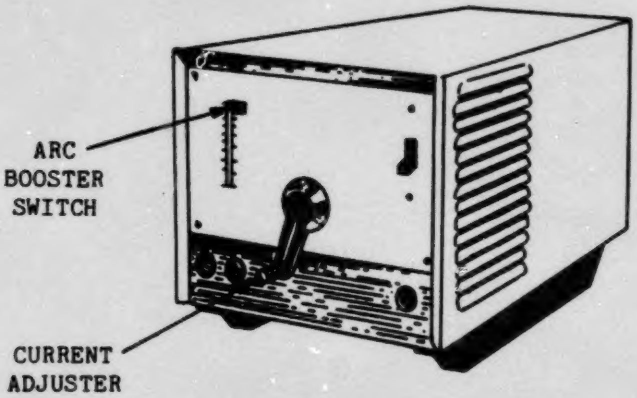
REVERSED POLARITY (DCRP)

DIRECT CURRENT STRAIGHT POLARITY

DIRECT CURRENT RESERVE POLARITY

TRANSPARENCY VII-1-D

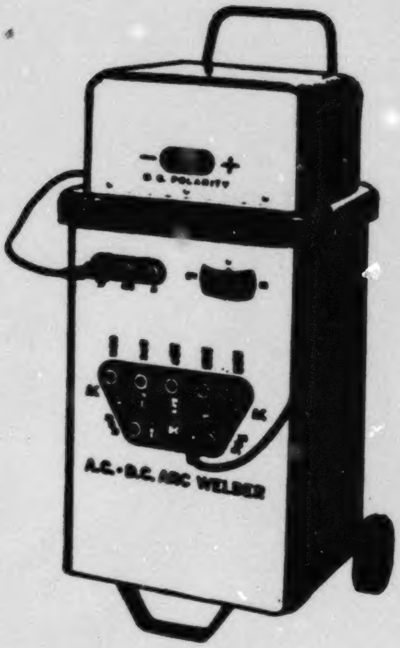
TRANSFORMERS FOR ALTERNATING CURRENT


ARC
BOOSTER
SWITCH
CURRENT
ADJUSTER

TRANSFORMER WELDING MACHINE PRODUCES ALTERNATING CURRENT.

TRANSPARENCY VII-1-E

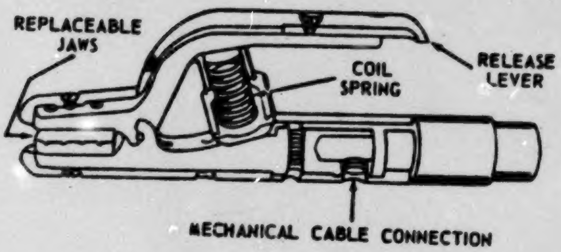
RECTIFIERS -- CHOICE OF CURRENTS

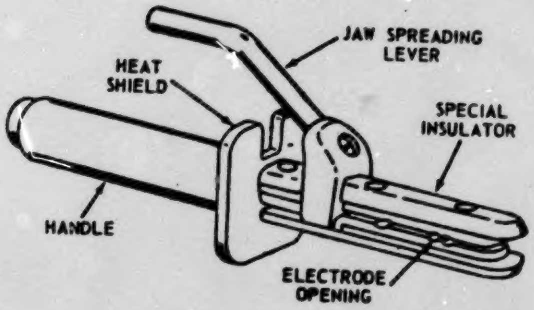

D.C. POLARITY
A.C.-D.C. ARC WELDER

Rectifiers provide DC current only or both DC & AC welding currents

Transparency VII-1-F

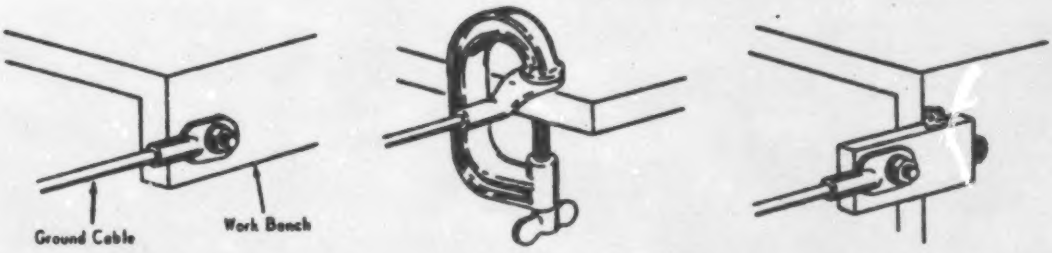
PARTS OF THE ELECTRODE HOLDER


REPLACEABLE JAWS
COIL SPRING
RELEASE LEVER
MECHANICAL CABLE CONNECTION


JAW SPREADING LEVER
HEAT SHIELD
SPECIAL INSULATOR
HANDLE
ELECTRODE OPENING

TRANSPARENCY VII-1-G

TYPES OF GROUNDING CLAMP CONNECTION

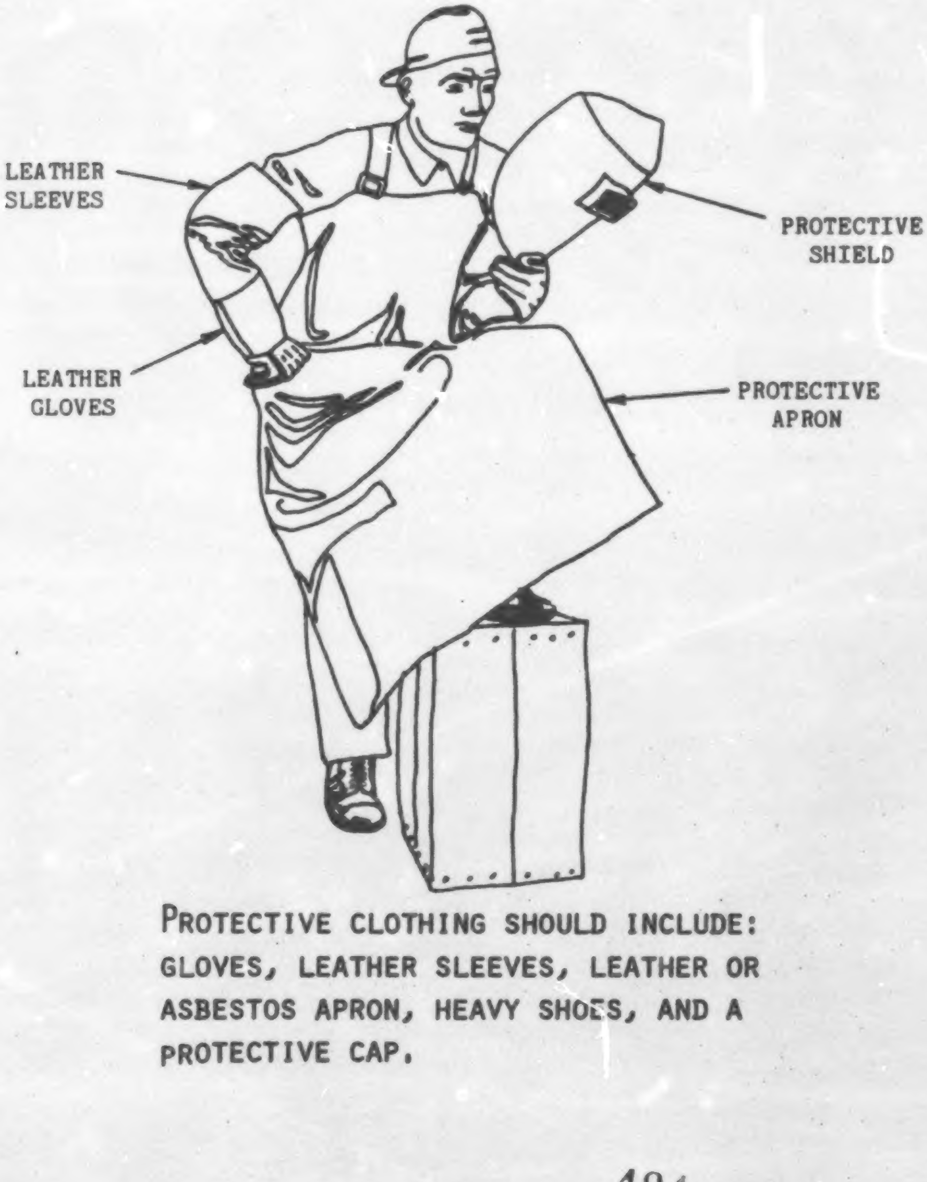

Ground Cable
Work Bench

BOLTED CLAMPED TACK WELDED

WITHOUT PROPER GROUNDING, THE FULL POTENTIAL OF THE CIRCUIT WILL FAIL TO PROVIDE THE REQUIRED HEAT FOR WELDING.

TRANSPARENCY VII-1-H

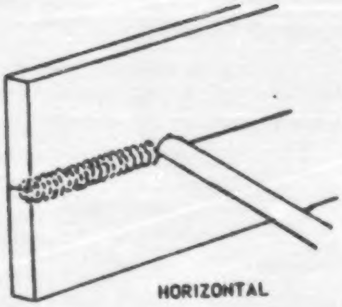
THE WELDER'S PROTECTIVE CLOTHING


LEATHER SLEEVES
PROTECTIVE SHIELD
LEATHER GLOVES
PROTECTIVE APRON

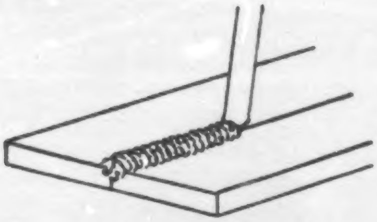
PROTECTIVE CLOTHING SHOULD INCLUDE: GLOVES, LEATHER SLEEVES, LEATHER OR ASBESTOS APRON, HEAVY SHOES, AND A PROTECTIVE CAP.

TRANSPARENCY VII-1-I

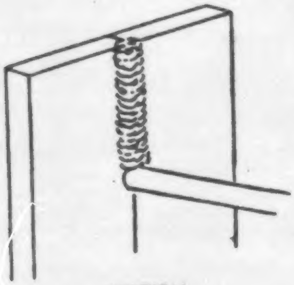
FOUR BASIC ARC WELDING POSITIONS



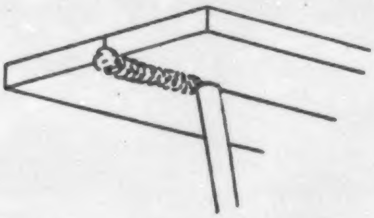
HORIZONTAL



FLAT



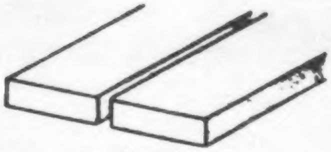
VERTICAL



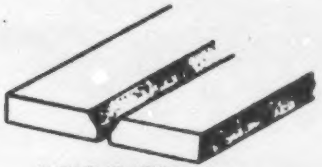
OVERHEAD

TRANSPARENCY VII-1-J

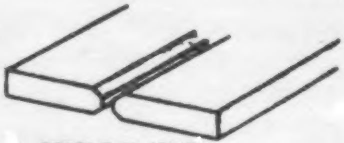
BASIC TYPES OF JOINTS USED IN ARC WELDING



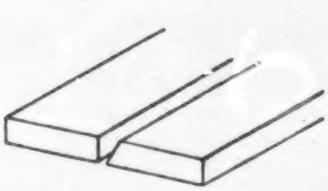
BUTT JOINT



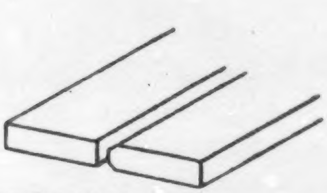
SINGLE V-JOINT



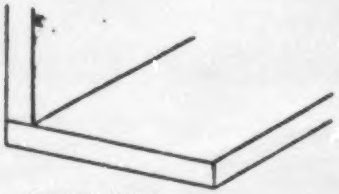
DOUBLE V-JOINT



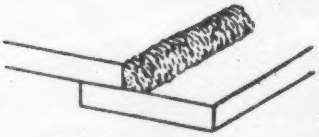
SINGLE BEVEL JOINT



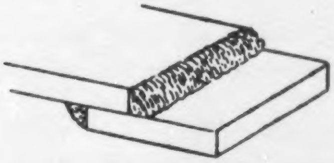
DOUBLE BEVEL JOINT



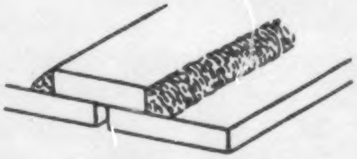
CORNER JOINT



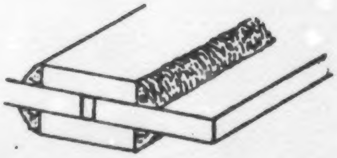
SINGLE FILLET LAP JOINT



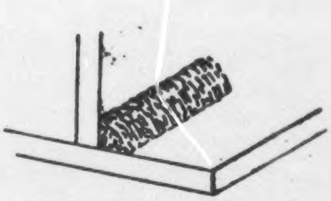
DOUBLE FILLET LAP JOINT



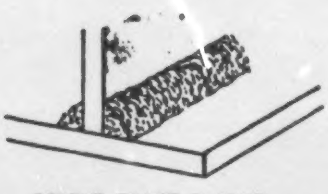
SINGLE STRAP JOINT



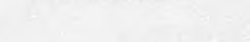
DOUBLE STRAP JOINT



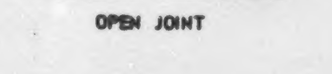
SINGLE FILLET T-JOINT



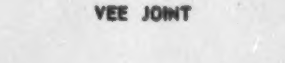
DOUBLE FILLET T-JOINT



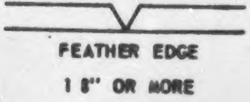
CLOSED JOINT



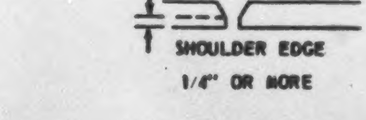
OPEN JOINT



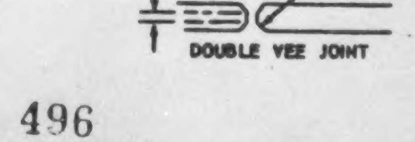
VEE JOINT



FEATHER EDGE
1 8" OR MORE



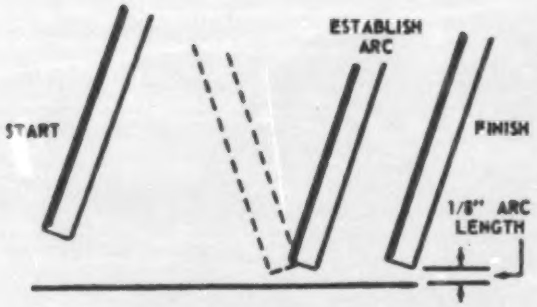
SHOULDER EDGE
1/4" OR MORE



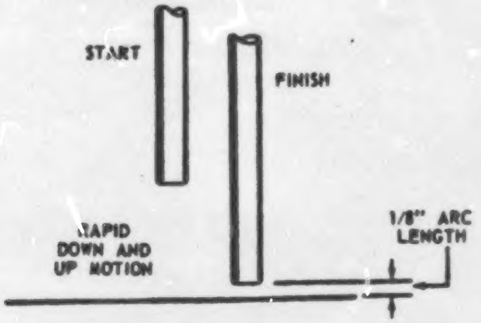
DOUBLE VEE JOINT

TRANSPARENCY VII-1-K

TWO METHODS USED TO START THE ARC


START
ESTABLISH ARC
FINISH
1/8" ARC LENGTH

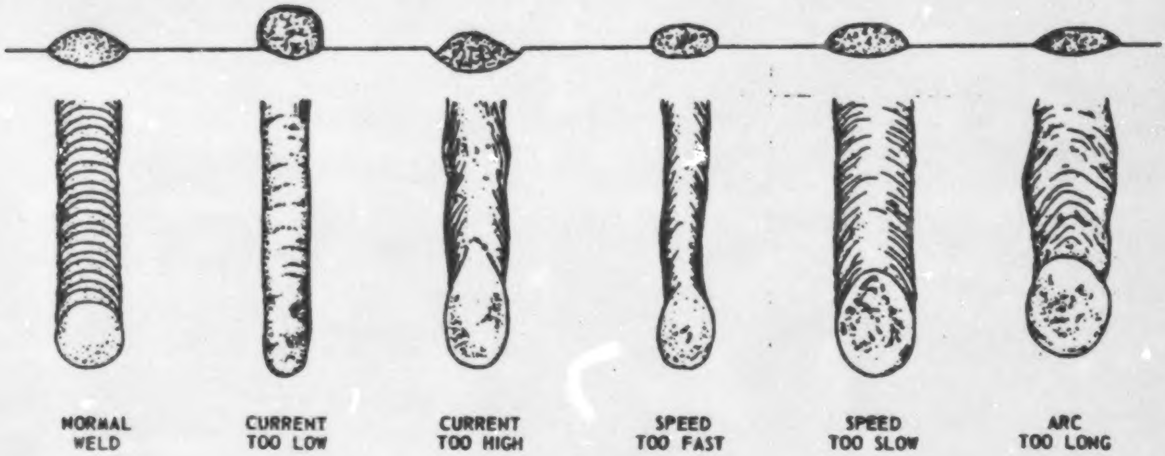
SCRATCHING METHOD


START
FINISH
RAPID DOWN AND UP MOTION
1/8" ARC LENGTH

TAPPING METHOD

TRANSPARENCY VII-1-L

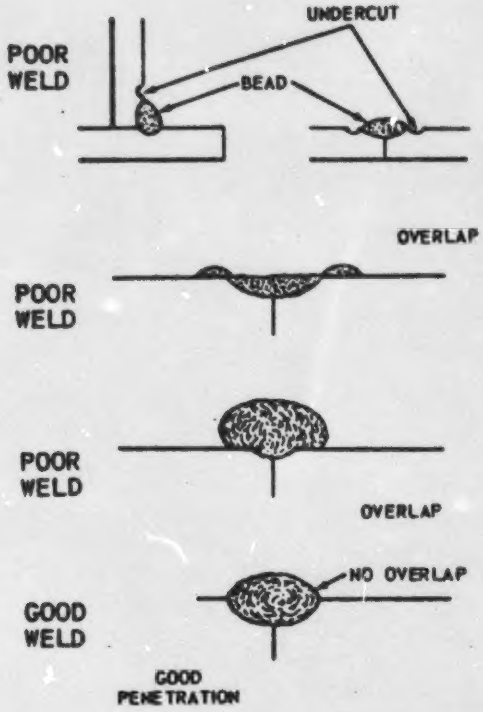
NORMAL AND ABNORMAL WELDS


NORMAL WELD
CURRENT TOO LOW
CURRENT TOO HIGH
SPEED TOO FAST
SPEED TOO SLOW
ARC TOO LONG

SOME OF THE REASONS WHY ALL WELDS DO NOT APPEAR AS THE NORMAL WELD SHOWN ABOVE ARE GIVEN WITH AN EXAMPLE OF EACH.

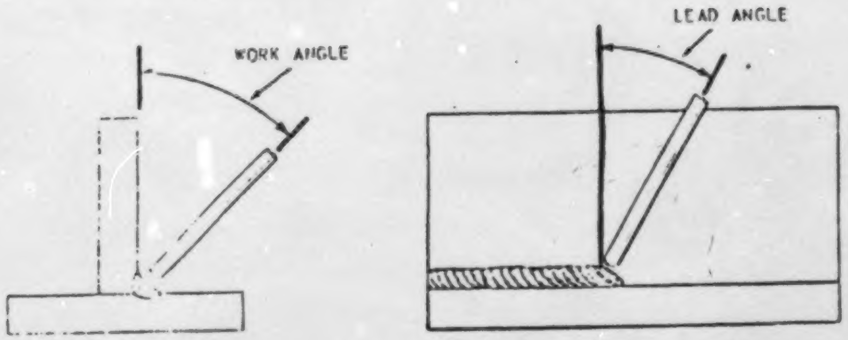
TRANSPARENCY VII-1-M

UNDERCUTTING AND OVERLAP


POOR WELD
UNDERCUT
BEAD
OVERLAP
POOR WELD
POOR WELD
OVERLAP
NO OVERLAP
GOOD WELD
GOOD PENETRATION

TRANSPARENCY VII-1-N

LEAD AND WORK ANGLES

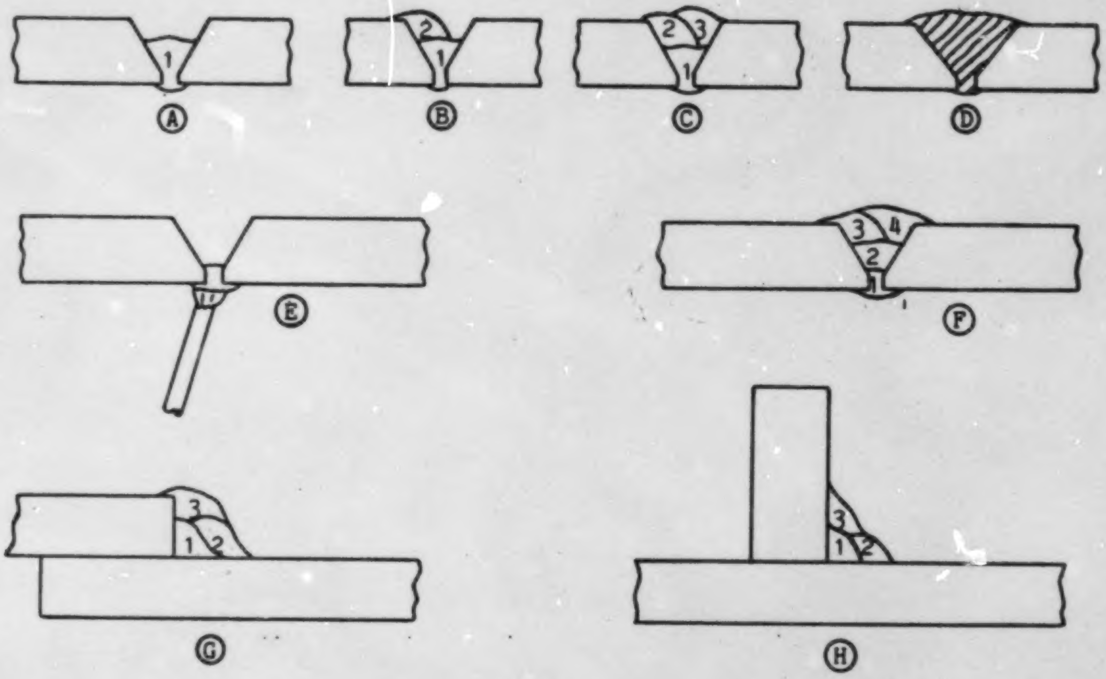


LEAD ANGLE -- ANGLE BETWEEN JOINT AND ELECTRODE WHEN VIEWED IN A LONGITUDINAL PLANE

WORK ANGLE -- ANGLE BETWEEN THE ELECTRODE AND THE WORK VIEWED FROM AN END PLANE

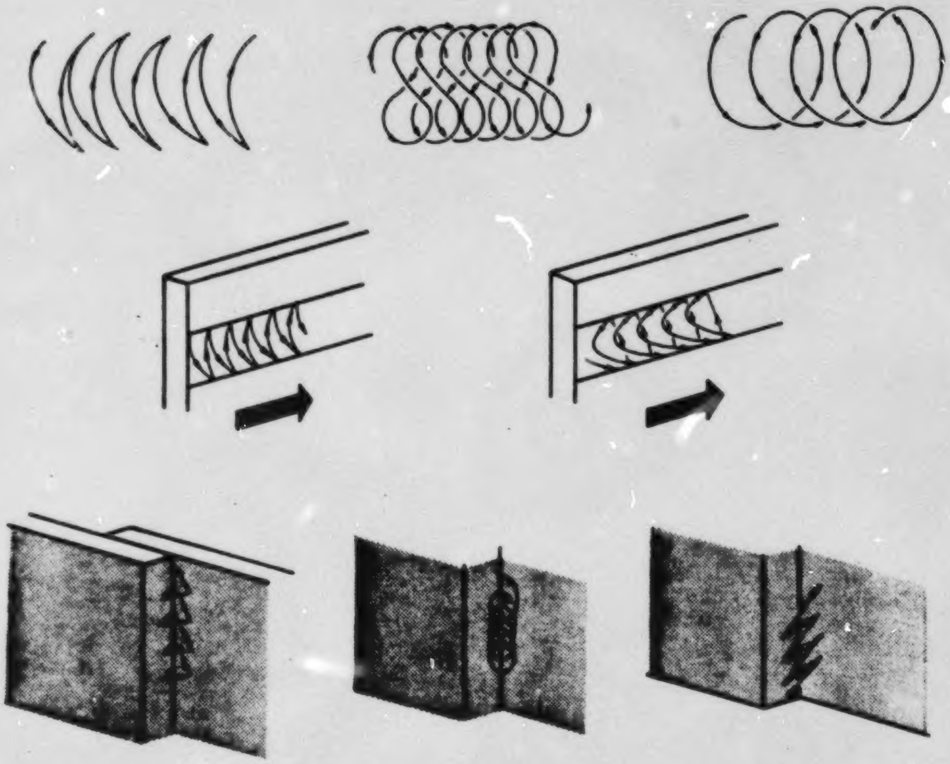
TRANSPARENCY VII-1-0

SINGLE AND MULTIPLE PASS WELDS


1
A
2
1
B
2
3
1
C
D
1
E
3
4
2
1
F
3
1
2
G
3
1
2
H

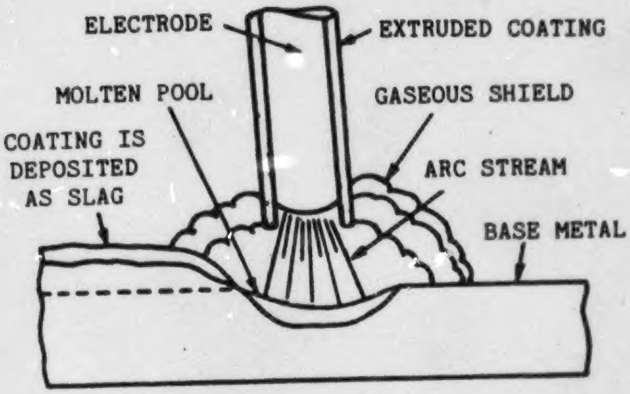
TRANSPARENCY VII-1-Q

TYPES OF WEAVING TECHNIQUES AND PATTERNS



TRANSPARENCY VII-1-R

THE ARC STREAM


ELECTRODE
EXTRUDED COATING
MOLTEN POOL
GASEOUS SHIELD
COATING IS DEPOSITED AS SLAG
ARC STREAM
BASE METAL

TRANSPARENCY VII-1-S

INSTRUCTIONAL AREA: Agricultural Mechanics

INSTRUCTIONAL UNIT VII: Arc Welding

Lesson 2: Shop Exercises in Arc Welding

I. Preparation for Instruction

A. Student Objectives

1. Terminal: Demonstrate the skills required for each welding exercise.

2. Specific:

a. Demonstrate ability and skills required to strike an arc, start the bead, stop the bead, and to restart the bead.
b. Demonstrate ability and skills required in running a bead in the flat position.
c. Demonstrate ability and skills required in running a bead in the horizontal position.
d. Demonstrate ability and skills required in running a bead in the vertical position:
    1) Vertical down, and
    2) Vertical up.
e. Demonstrate ability and skills required in running a bead in the overhead position.
f.

g.

h.

B. Review Teaching Material

1. Phipps, L.J. Mechanics in Agriculture. Danville, Ill.: Interstate Publishing, 1977.

2. McCoy, V.L, and T.J. Wakeman. The Farm Shop. New York: MacMillan Publishing Company, 1960.

C. Special Arrangements

1. Arc welders and equipment, and

2. Materials as indicated in each exercise.

II. Presentation of Lesson

A. Motivation

To become proficient in arc welding, the student must master certain basic steps and skills. This lesson will give a beginner exercises that are needed to master the skills. The exercises are so arranged that none are extremely difficult to accomplish, with each exercise building and adding on to the previous skills acquired.

B. Content Outline

1. Procedure for running beads in various positions. Acquiring skills necessary to run a bead by using paper and pliers to practice the arc welding procedure. Proceed as follows:

   a. Prepare a piece of paper as shown in Transparency VII-2-A. For 1/8" electrode allow 5/16" space for bead; for a 5/32" electrode allow 25/64" space for bead; for a 3/16" electrode allow 15/32" space for bead.

   b. Clamp a pencil in a set of pliers, electrode holder, or a mock-up of an electrode holder (may be made of a piece of wood or other material).

   c. Support hands in a comfortable welding position. Learn to use both hands.

   d. Lean the pencil 15-20 degrees in the direction of travel.

   e. Using a weaving motion and enough pressure on the pencil to make light marks, begin on one of the three bead spaces drawn on the paper; continue completely across the length of the bead space. Repeat for each bead size and direction.

   f. Draw three straight lines on the paper; on one line, weave as though it were a 1/8" electode; on the second line proceed as though it were a 5/32" electrode; and the third line as though it were a 3/16" electrode. Check to ensure proper weld width. Repeat these steps as many times as necessary.

2. Starting, stopping and restarting the electrode. The following materials will be needed for this exercise:

   1 piece of clean, mild steel, 3/16" X 2" X 12"
   1/8" electrodes, E-6013
   Welding amperage in the range of 115-145

   Substitutions for materials listed above may be made at the discretion of the teacher.

a. Place electrode in 60 degree groove of the electrode holder's jaws.

b. Grip holder in right hand, support it with the left.

c. Strike the arc (use the scratching method, much like striking a match), without leaving a mass of weld deposit (metal) at the beginning of the bead. Immediately after striking the arc, hold the electrode vertically about 1/4" from the base metal for a count of 2 to form a molten puddle and to preheat the metal. When the puddle is formed, lower the electrode to within 1/8 in of the base metal (diameter of the electrode). Angle the electrode 15 degrees and start laying a bead to your right.

d. To eliminate a crater being formed at the end of the bead, follow these steps:

    1) Lower the electrode close to the molten puddle in a vertical position.

    2) Hold for a 4 to 7 count to fill the crater.

    3) When a crater is filled, raise the electrode quickly, which breaks the arc.

e. To restart a bead once the arc has been broken (for any reason), proceed as follows:

    1) Clean the slag, and

    2) Follow the procedure in "c" above.

3. Welding in the flat position, the following materials will be needed:

1 piece of mild steel, 3/16" X 5" X 10", cleaned (free from rust).
1/8" electrode for 3/16" plate or 5/32" electrode for 1/4" plate; E-6013.
Welding amperage in the range of 115-170

Substitutions for materials listed above maybe made at the discretion of the teacher.

Proceed as follows:

a. Place metal on a flat surface.

b. Place electrode in 60 degree groove of electrode holder until first half of the electrode is used; then in the 90 degree groove. Proceed as follows:

1) First layer: welding at about 130 amps, begin at top left corner; lay the bead from left to right; angle electrode approximately 15 degrees in the direction of travel. Continue running beads across the length of the plate; completely fill-up the plate with beads, lapping each bead approximately half of it width, except the last bead. Clean each bead as it is completed before laying the next bead.

2) Since the plate is now thicker than when this exercise started, increase the amperage approximately 10-15 more amperes. Divide the plate in half with a piece of chalk. Begin at the top, holding the electrode approximately 15 degrees in the direction of travel, and weld toward the bottom of the plate (toward the person doing the welding), welding the bead to within 1/2" on the bottom. This 1/2" is to allow exposure of the first layer. Continue welding from top to bottom by completely filling up half of the pad. On the other half of the pad or plate, weld away or weld from the bottom to the top, starting each bead 1/2" from the bottom. (Transparency VII-2-B)

3) Third layer: increase the amperage approximately 15 amperes to allow for the thickness of the pad. This time cover all of the plate except 1" at the bottom. Run the beads from right to left.

The plate will become curved (because of the heat) with all three layers exposed when the project is completed. (Transparency VII-2-B)

4. Welding in the horizontal position, the following materials will be needed:

   1 piece of mild steel, 3/16" X 5" X 12"
   Electrodes, 1/8" and 5/32", E-6013
   Amperage range of 115-130 for 1/8" electrode and range of 125-170 for 5/32" electrode.

   Proceed as follows:

   a. Clamp the practice plate to the table, or position it so that it will be in the upright position (may weld it to another piece of metal or use a welding positioner as shown in Transparency VII-2-C).

   b. Beginning at the bottom left corner of the plate, lay a bead across the width of the plate. Practice starting and stopping as in the second exercise. If the beads are welded correctly (making sure to lap every bead about half its width and holding a close arc), the beads will not have to be cleaned. The slag will fall off in sheets when it cools. Continue making the beads until the top is reached, making a solid layer.

   c. Dip the plate in water approximately at the time that two electrodes have been used up (cool the plate at least once for every two electrodes used). Make sure that gloves and tongs are used (the steam can seriously burn hands) to submerge the plate.

5. Welding in the vertical down position, the following materials will be needed:

   1 piece of mild steel 1/4" X 2" X 10"
   Electrodes, 1/8", E-6011
   Amperage approximately 115 amperes

   Substitutions for materials listed above maybe made at the discretion of the teacher.

   Proceed as follows:

a. Secure the plate in the vertical position. Place the electrode in the 120 degree groove of the electrode holder and angle it at 15 degrees in the direction of travel.

b. Start the bead in the upper left-hand corner of the plate; weld downward to the bottom. Keep the arc short. Move fast enough to be ahead of the downward movement of slag. If the electrode sticks, increase the amperage. If the base metal tends to run, check the length of the arc; remember, it has to be a short arc.

c. Make beads 1/4" apart until they cover the plate. A good way to check to see if proper penetration is occurring is to saw the welds in half and examine the depth of penetration.

6. Another exercise in welding is the vertical down position. The following materials will be needed:

1 piece sheet metal, 1/16" X 6" X 6"
Electrodes, 1/16" and 3/32", E-6013
Amperage in the range of 50-70 amperes for 1/16" and 60-90 amperes for 3/32" electrodes.

Substitutions for materials listed above maybe made at the discretion of the teacher.

Proceed as follows:

a. Follow the procedure as in step "a" in the procedure above.

b. Start the arc, move electrode to a distance of 3/16" from the base metal; this long an arc is needed to preheat the metal. If arc continually goes out, increase the amperage slightly.

c. Start the bead in the upper lefthand corner, welding down. Increase the speed and motion if the electrode is burning a hole in the base metal. An individual may have to practice this a few times to get it right.

d. Clean the beads; they should look like the vertical down beads in the previous exercise except they will have slightly less penetration.

e. Run the beads approximately 1/4" apart until the plate is covered. It is suggested that an individual vary the speed, change the weaving motion, and change the electrode angle occasionally to observe the results of such changes.

7. Welding in the vertical up position, the following materials will be needed:

1 piece of mild steel, 1/4" X 2" X 12"
Electrodes, 1/8", E-6011
Amperange range of 105-130 amperes

Proceed as follows:

a. Secure the plate as before (vertical position).

b. Place the electrode in the 120 degree groove of the electrode holder.

c. Start at the bottom left-hand corner of the plate and run the bead upward.

d. Start with a long arc to heat the base metal; then on half of the plate, lay practice beads up to 1/2" in width, using a regular weaving motion. Use the other half of the plate for beads over 1/2" in width.

e. For all the beads, try to get maximum penetration and try to keep the metal from sagging. For beads 1/2" and under in width, the rise should not be any greater than 1/8"; for wider beads, not more than 3/32" in height.

8. Welding in the overhead position, the following materials will be needed:

1 piece of mild steel plate, 1/4" X 2" X 12"
Electrodes, 1/8", E-6011
Amperage range from 100-120 amperes

Substitutions for materials listed above maybe made at the discretion of the teacher.

a. Secure the practice plate in an overhead position. The welding positioner is especially useful for this exercise. Be sure take extra precautions for protection against hot dripping molten metal.

b. Place the electrode in the 180 degree groove of the holder.

c. Strike a long arc, and hold to a six count to help preheat the practice plate. If the electrode sticks, increase the amperage.

d. Use a weave pattern as in previous exercises.

e. Do not practice for long periods of time. At the end of 30 minutes, take a five minute break.

f. Check the effect of each movement in the weaving pattern.

9. Any number of exercises in arc welding can be derived by adding or changing any of the variables listed above in exercises 1-8. The following is a list that may be added to the above exercises as skills are developed by the individual students:

   a. Butt welds in the flat position:

      1) Square butt weld,

      2) Single-vee butt weld, and

      3) Double-vee butt weld.

   b. Butt welds in other positions:

      1) Double-vee butt weld in vertical position,

      2) Single-vee butt weld in overhead position, and

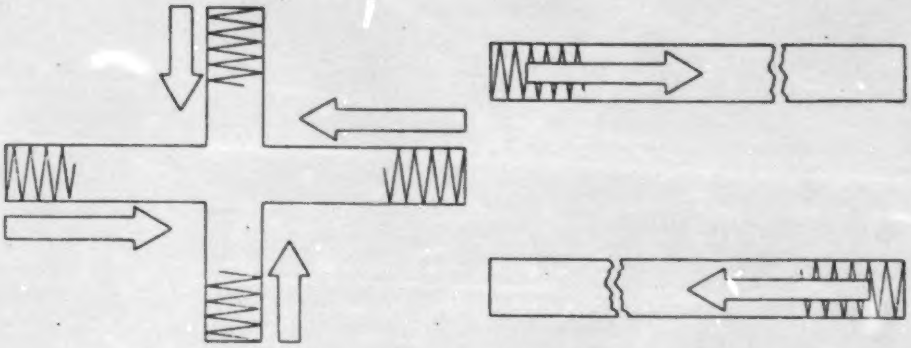
      3) Single-vee butt weld in horizontal position.

   c. Fillet welds in flat position:
      1) Lap weld, and
      2) Tee-joint weld.
   d. Fillet welds in vertical position
      1) Lap weld, and
      2) Tee-joint weld

C. Suggested Student Activities

The suggested student activity is for the individual students to perform the exercises as listed above (at the discretion of the teacher, these exercises can be modified in several ways).

PRACTICE PROCEDURE FOR ARC WELDING

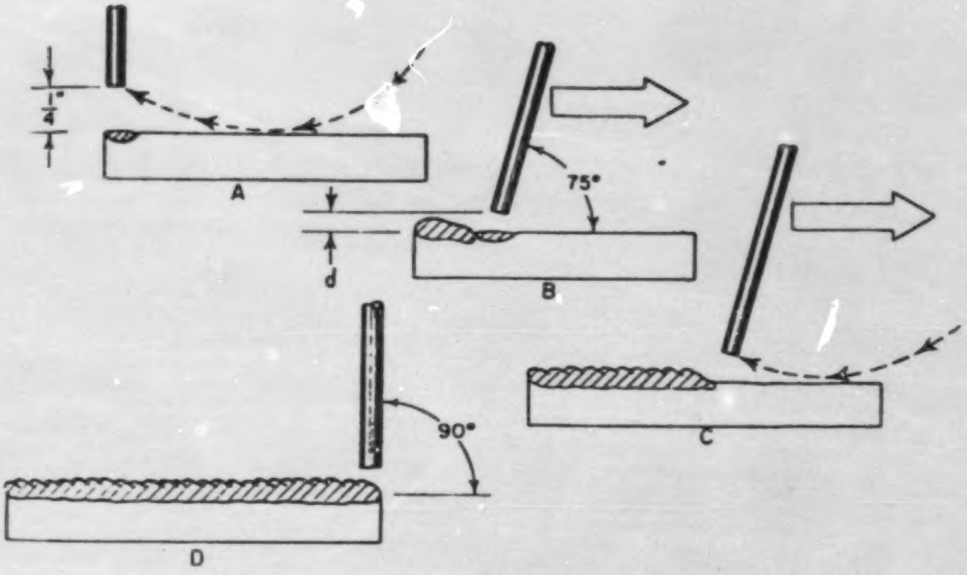


PREPARE PAPER CHARTS LIKE THIS FOR PLIER-AND-PENCIL (SPACE BETWEEN LINES IS BEAD SIZE).

ELECTRODE SIZE	INCHES ALLOWED FOR SPACE
1/8	5/16
5/32	25/64
3/16	15/32

TRANSPARENCY VII-2-A

STARTING AND STOPPING THE ARC



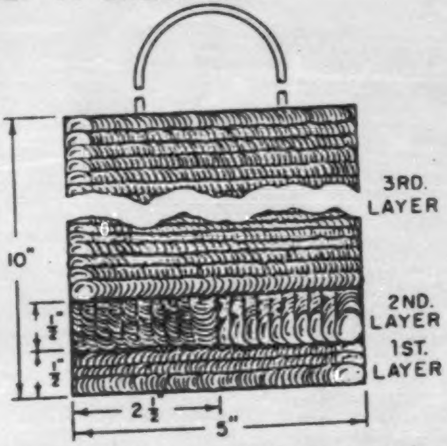
1"/4
A
75°
d
B
C
90°
D

A- Strike; hold electrode vertical 1/4" above metal, for a count of two, to form molten pool.

B- When pool is formed, tilt electrode; start bead

C- Restarting bead

D- To stop, hold close arc for 4-7 count to fill crater; raise quickly to break arc

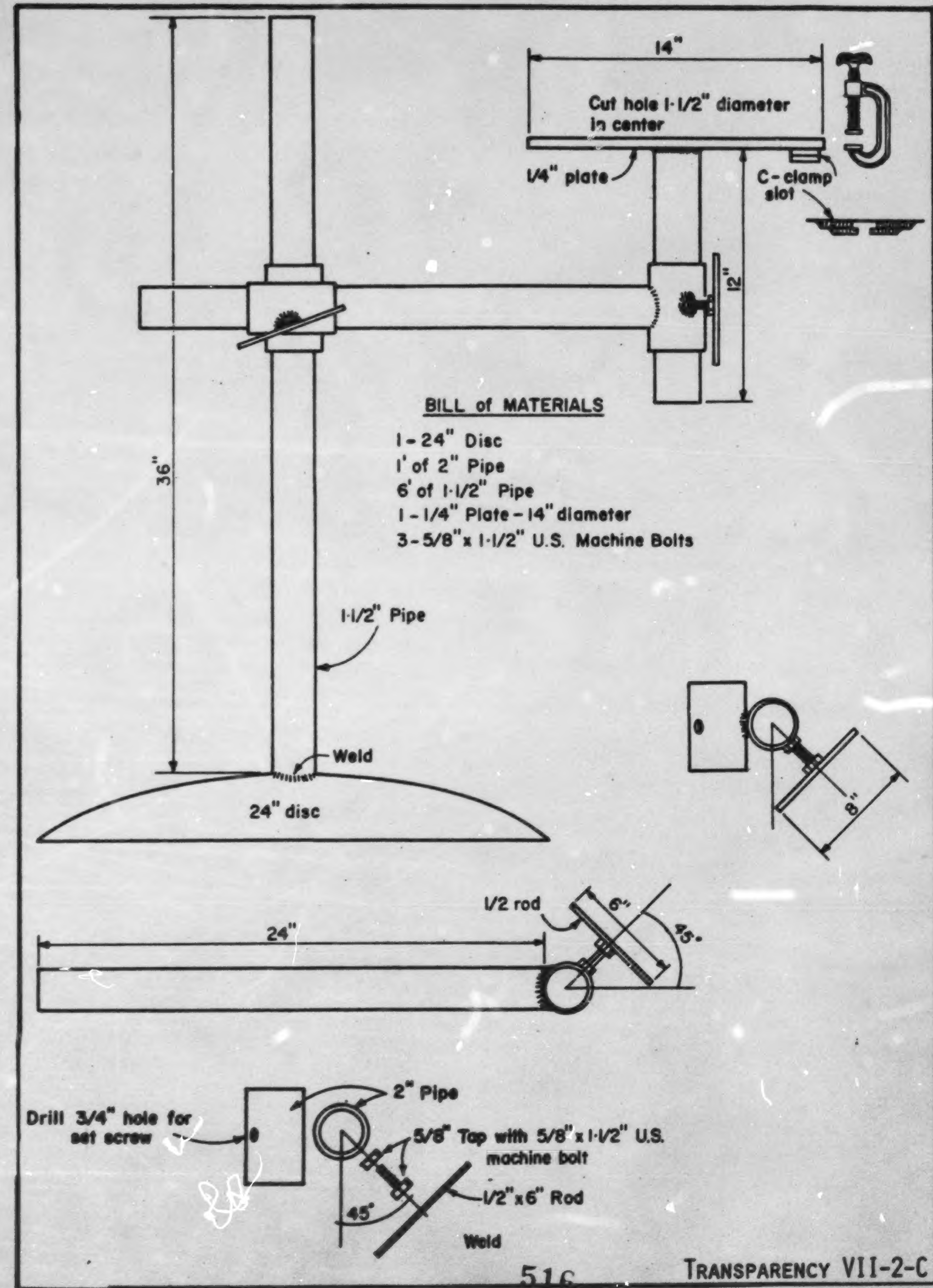


3RD. LAYER
10"
2ND. LAYER
1ST. LAYER
1/2"
1/2"
2 1/2
5"

Exercise Plate for Arc Welding

Transparency VII-2-B

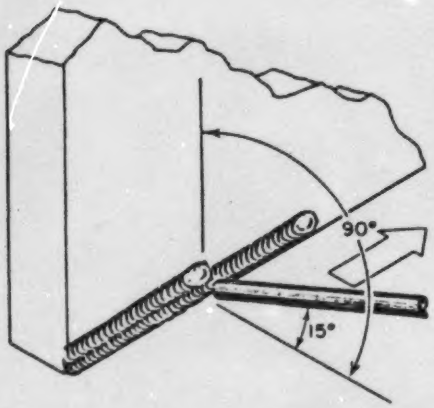
WELDING POSITIONER


14"
Cut hole 1-1/2" diameter in center
1/4" plate
C-clamp slot
12"
36"
1-1/2" Pipe
Weld
24" disc
8"
1/2 rod
6"
45°
24"
2" Pipe
Drill 3/4" hole for set screw
5/8" Tap with 5/8" x 1-1/2" U.S. machine bolt
1/2" x 6" Rod
45°
Weld

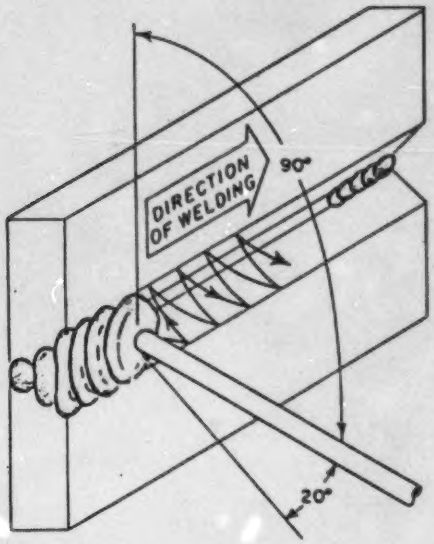
BILL of MATERIALS

1 - 24" Disc
1' of 2" Pipe
6' of 1-1/2" Pipe
1 - 1/4" Plate - 14" diameter
3 - 5/8" x 1-1/2" U.S. Machine Bolts

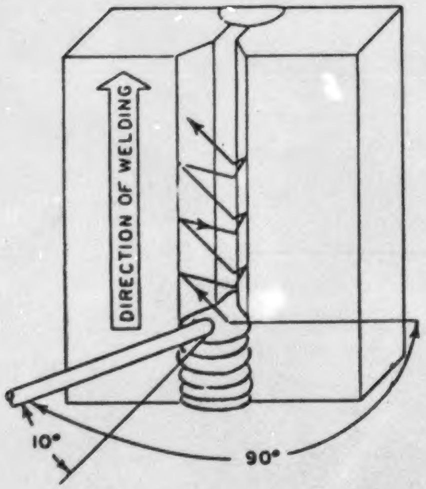
HORIZONTAL AND VERTICAL WELDING



Horizontal Welding Angles


DIRECTION OF WELDING
90°
20°

A Horizontal Vee-butt Weld


DIRECTION OF WELDING
10°
90°

A Vertical Vee-butt Weld

Transparency VII-2-D